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ORIGINAL ARTICLE

Role of Otoacoustic Emission Test in Early Diagnosis of Hearing Impairment in Infants

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Abstract Hearing impairment is most common congenital dissorder and undiagnosed hearing loss can cause disorder in speech, language with delay in social and emotional developments. Early detection of Hearing Impairment in Infants and too access the relationship between selected risk factor and hearing loss. Neonates age upto 15 days randomly selected from pediatric and obstetrics and gynaecology department, born during this period were screened by OAE before their discharge from the hospital and after stabilizing high risk neonates. Informed consent of neonates parent/guardian was obtained before babies were subjected to OAE. A total of 400 neonates were screened for hearing loss by otoacoustic emission. Out of that 18 (4.5%) neonates failed the test in initial screening and were asked for follow up screening. Two neonates were lost to follow up. Out of 16 neonates, 2 (12.5%) neonate failed the test on follow up screening by otoacoustic emission and was referred for BERA. Neonates were classified as low and high risk basis of risk factors present. Out of 76 neonates having high risk of hearing loss, 16 failed the test. Similarly out of 324 neonates with low risk of hearing loss, only one neonate failed the test. Chi square analysis has revealed highly significant results ($p < 0.001$). Late identification of hearing loss presents a significant public health concern. However, without screening, children with hearing loss are usually not identified until 2 years of age, which results in significant delays in voice communication, language communication, social, cognitive, and emotional development. In contrast, early recognition, and intervention prior to 3 months of historic period has a significant positive impact on development.

Keywords Hearing impairment · Infants · Otoacoustic emission

Introduction

Hearing plays a significant role in language and intellectual development. Deaf child cannot learn language as language can only be learnt through hearing. As the deaf child does not learn language the child cannot speak. A hearing impaired child develops psychological, social, educational and even cognitive problem. This happens even if the child is partially hearing impaired and not totally deaf [1].

Critical language learning period of a child is from birth to about three and half year of age if the child has a hearing loss during this age the child cannot hear and so cannot learn language. After this critical language learning age the language learning faculty of the brain becomes impaired. This means that if hearing deficit is corrected before the child is of six months age, the development of speech and language is more or less normal and equal to that of a normal hearing child. Therefore early screening is best way to prevent further hearing related disorder. Congenital and acquired hearing loss in newborn and children can lead to deficiencies and defect in evaluation of speech, poor education function and lifelong social concurrence and emotional distress [2, 3].

Hearing screening of newborns aims at early detection of imbalances or hearing defects, whose early detection can prevent improper or inadequate development of communication skills. Earlier the hearing impairment is diagnosed,

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greater the child has a chance of inclusion in everyday life. The importance of hearing screening is also confirmed by the fact that hearing loss is likely to be the most common congenital abnormality in human, more than 80% of hearing defects are congenital or arise in the perinatal period [4].

Aim and Objective

Early detection of Hearing Impairment in Infants and too access the relationship between selected risk factor and hearing loss.

Material and Method

This is a Prospective, Cohort, Observational Analytical study Carried out at Gandhi Medical College and associated hospital by ENT (Otorhinolaryngology) Department, Gandhi Medical College, Bhopal carried during March 2017 to—Aug 2018. Neonates age upto 15 days randomly selected from pediatric and obstetrics and gynaecology department born during this period were screened by OAE before their discharge from the hospital and after stabilizing high risk neonates. Informed consent of neonates parent/guardian was obtained before babies were subjected to OAE.

Low risk newborns comprised of babies from post natal ward while high risk neonates were babies with one or more of below mentioned risk factors (Joint Committee on Infant Hearing 1994 criteria).

1. Family history of hereditary childhood SNHL.
2. Intrauterine infection, such as CMV, rubella,herpes, syphilis, and toxoplasmosis.
3. Craniofacial anomalies including those with morpological abnormalities.
4. Birth weight less than 1,500 g (1.5 kg).
5. Hyperbilirubinemia not requiring exchange transfusion.
6. Ototoxic medications during pregnancy
7. Ototoxic medications during neonatal period.
8. APGAR scores of 0–4 at 1 min or 0–6 at 5 min
9. Mechanical ventilation (5 days or more)
10. Stigmata or other findings associated with a syndrome known to SNHL
11. Prematurity (gestational age < 37 weeks)
12. Neonats suffering from bacterial meningitis

All neonates, both low and high risk were screened by were 0AE & neonates with abnormal OAE were followed for second OAE after 2 weeks.

Criteria (pass/refer) a newborn must pass the screening in both ears during one session for the screening to be considered a' pass' otherwise,the newborn will be referred for rescreening, if the newborn does not pass in one ear, both ears must be rescreened.

Pass: Reliable OAE response present at < 2 5 dBHL or both ears.

Refer: Reliable OAE response absent at < 25 dBHL from either ear.

The data obtained was subjected to statistical analysis with consultation of a statistician. The data so obtained was compiled systematically. A master table was prepared and the total data was subdivided and distributed meaningfully and presented as individual tables along with graphs analysed statistically.

Statistical procedures were carried out in 2 steps:

1. Data compilation and presentation
2. Statistical analysis

Statistical analysis was done using Statistical Package of Social Science Data comparison was done by applying specific statistical tests to find out the statistical significance of the variables.

Quantitative variables were compared using mean values and qualitative variables using proportions. Significance level was fixed at $P < 0.05$.

Variables

Demographic variables
Age.
Sex.
Religion.

Othervariable
High risk criteria.
OAE[initial and follow up].

Inclusion criteria

All consecutive born neonates (low and high risk group) delivered in obstetrics and paediatrics department in Gandhi Medical college and associated hospital during study period were included in the study, whose parents had consented to participate in the study.

Exclusion criteria
Infant more than 15 days of age
Congenital head and neck deformilities.
Infant with acute illness

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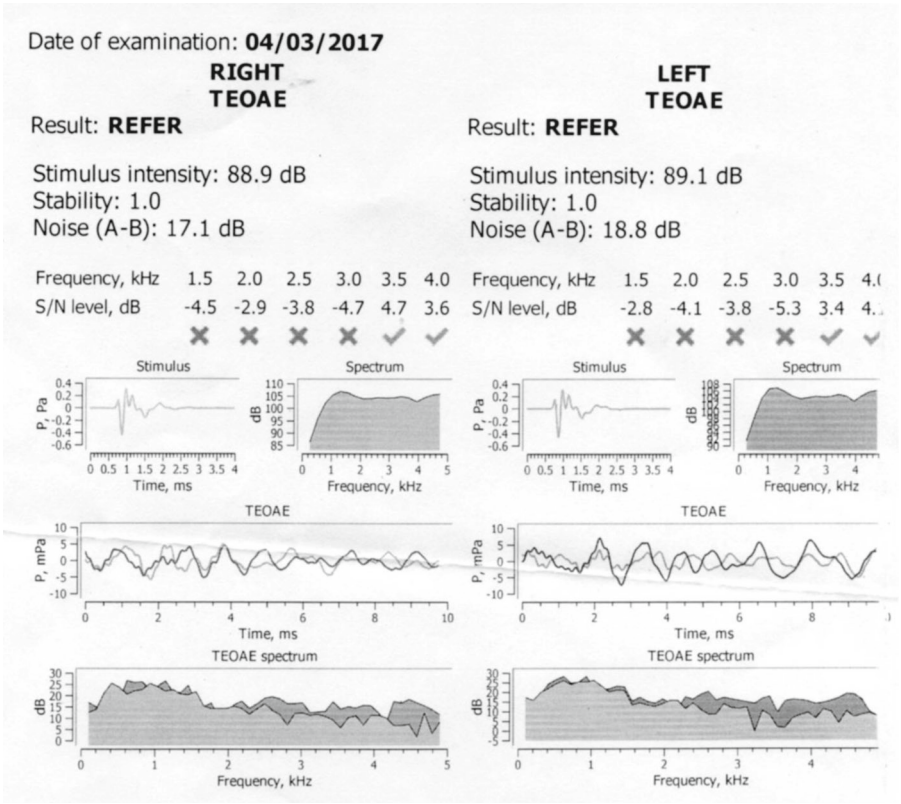

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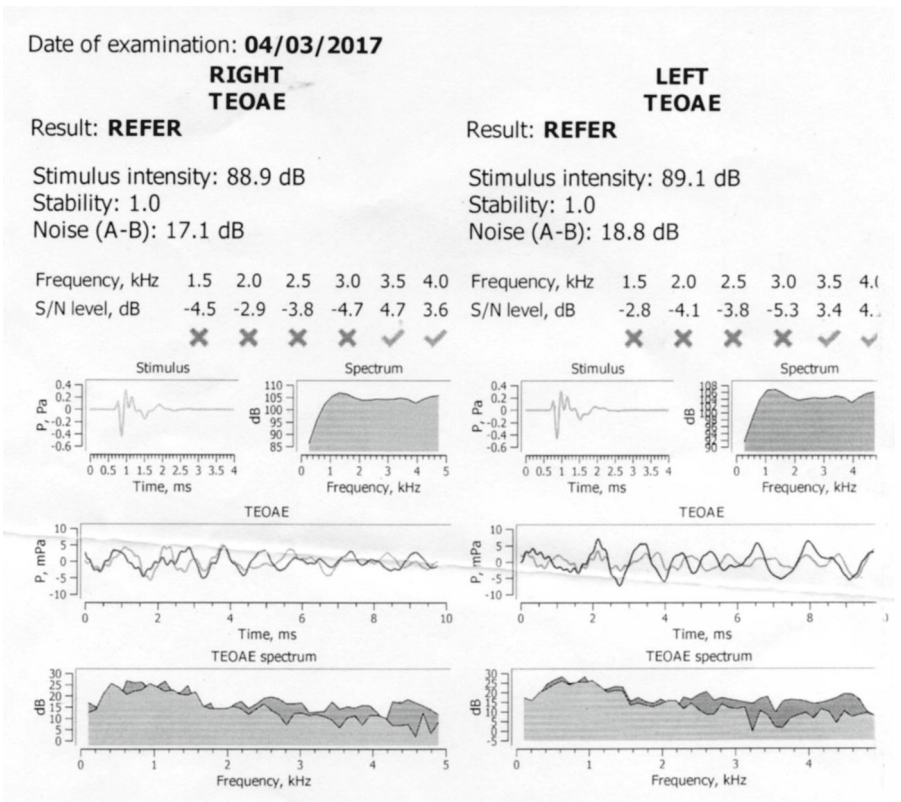

Results

Table no 1 show that a total of 400 neonates were screened for hearing loss by otoacoustic emission. Out of that 18 (4.5%) neonates failed the test in initial screening and were asked for follow up screening. Two neonates were lost to follow up. Out of 16 neonates, 2 (12.5%) neonate failed the test on follow up screening by otoacoustic emission.

Neonates were classified as low and high risk basis of risk factors present. Table 2 showed that out of 76 neonates having high risk of hearing loss, 16 failed the test. Similarly out of 324 neonates with low risk of hearing loss, only two neonate failed the test. Chi square analysis has revealed highly significant results ($p < 0.001$).

Table no 3 shows that a total 16 neonates were screened on follow up. Out of 14 neonates who were at high risk, 2 failed the test. Only two neonates were at low risk on follow up who passed the test. Chi square test revealed insignificant results ($p = 0.986$).

Table 4 shows that out of 18 failed OAE neonates, association with risk factor in percentage. Contribution of each risk factor to total hearing loss is been demonstrated.

Discussion

The importance of early diagnosis of hearing impairments is quite obvious, due to the fact that negligence in this regard will result in speech, lingual, cognitive, social and psychological developmental delay. (American Speech-Language-Hearing Association 2007).

The incidence of hearing impairments in infants with risk factors is 10 times higher, and is approximately 2–5%. In one study in USA, it was demonstrated that infants whose hearing impairment was identified in less than 6 months of age in the screening programs, have the same developmental prognosis as healthy infants. (Zamani A 2004) [5] In another study in the Netherlands, it was suggested that diagnosis before 3 months and treatment before 6 months will result in a good prognosis. (Ayache S 2001) [6].

Table 1 Showing screening algorithm in present study

Screening	Total neonates (n)	Test refer, n (%)		Test passed, n (%)	
	n	n	%	n	%
Initial	400	18	4.5	382	95.5
Follow up (1 lost in follow up)	16	2	12.5	14	87.5

Table 2 Comparing risk of hearing in neonates with the test status

S. No	Risk factor	Total	Test failed		Test passed		*P* value
		N	n	%	n	%	
1	Neonates with high risk	76	16	21.05	58	76.31	< 0.001
2	Neonates with low risk	324	2	0.6	322	99.4	
	Total	400	18		380		

Table 3 Classifying neonates on the basis of risk on follow up screening

S. No	Risk	Total	Test Failed		Test passed		*P* value
		N	n	%	n	%	
1	Neonates with low risk	2	0	0	2	100	0.986
2	Neonates with high risk	14	2	14.28	12	85.72	
	Total	16	2		14		

Table 4 Showing association with risk factor in percentage

Risk factor	Number	Percentage
Low Birth weight	2	11.11
Family history of hereditary childhood SNHL	0	0.00
INUTERO infection	2	11.11
Craniofacial Anomaly	0	0.00
Ototoxic Medication during Pregnancy	4	22.22
Ototoxic Med NEON	2	11.11
Hyperbilirubinemia	4	22.22
APGAR score < 5 in 1 min	4	22.22
APGAR score < 7 in 5 min	4	22.22
Mechanical Ventilation	6	33.33
Gestational age < 37 weeks	4	22.22
Bacterial Meningitis	2	11.11
Syndrome with SNHL	0	0.00

In present study a total of 400 neonates were screened for hearing loss by otoacoustic emission. Out of that 18 (4.5%) neonates failed the test in initial screening and were asked for follow up screening. One neonate was lost to follow up. Out of 16 neonates, 2 (12.5%) neonate failed the test on follow up screening by otoacoustic emission. In a survey by Gouri et al. reported that, among 415 of the total newborns screened 94.7% (393) cases passed on OAE while 5.3% cases were referred for

initial screening at birth. In a study by Vashistha et al. reported that of 100 children, 85 children have hearing within normal limits. Hearing impairment was found in 15 out of which 7 had unilateral hearing loss and 8 had bilateral hearing loss. The high prevalence of hearing loss in this population underlines the importance of early audiological testing. (Vashistha I 2016) [7] In a similar study by Gouri et al. reported that out of total 415 babies included in the study, 22 neonates showed abnormal OAE examination. Out of these 22 neonates, hearing loss was confirmed in 18 (82%) subjects. by AABR. (Gouri ZUH 2015) [8].

Present study on analyzing various risk factors and hearing loss using chi square test revealed that significant p value was found with low birth weight ($p < 0.001$), intake of ototoxic medication during Nagapoornima et al. conducted a similar study in India and screened a total of 1769 infants (1490: Not at risk; 279: At risk) & reported that 10 babies were having a hearing impairment. (Nagapoornima P 2007) [9] The high incidence of hearing impairment seen in our study population could be explained because of neonatal population with different geographical area and also because of different maternal antenatal risk factors. There can be also some unseen environmental and genetic and epigenetic factors responsible for the high incidence of hearing impairment in our studies.

John et al. conducted study in Christian Medical College (C.M.C.) Vellore and evaluated 500 newborns and found 32 (6.4%) neonates with negative response. These effects are quite comparable to our study. (John M 2009 [10] Farhat et al. enrolled 8987 neonates and reported that of all the subjects, 1231 cases (14%) failed the first OAE test, and 1004 neonates participated in the secondary OAE test to confirm the former obtained outcomes. (Farhat AS 2014) [11].

Study	Total neonates (n)	Test failed, n (%)	Test passed, n (%)
Nagapoornima et al. [9]	1769	10 (0.57)	1759 (99.43)
Gouri et al. [8]	415	22 (5.30)	393 (94.7)
John et al. [10]	500	32 (6.4)	468 (93.6)
Farhat et al. [11]	8,987	1,231 (19.7)	7756 (80.3)
Vashistha et al. [7]	100	15 (15)	85(85)
Present study	400	18 (4.5)	382 (95.5)

Conclusion

Late identification of hearing loss presents a significant public health concern. However, without screening, children with hearing loss are usually not identified until 2 years of age, which results in significant delays in voice communication, language communication, social, cognitive, and emotional development. In contrast, early recognition, and intervention prior to 3 months of historic period has a significant positive impact on development.

So, there is an urgent need to incorporate universal neonatal hearing screening in all the neonatal health care facilities in India.

Funding No funding from any source.

Data Availability Available in hospital record.

Declaration

Conflict of interest There was no conflict of interest of any author.

Ethical Approval Ethical approval was waived by local ethical committee of institution.

Informed Consent Taken from every patient.

References

1. Davis A, Wood S (1992) The epidemiology of childhood hearing impairment: factor relevant to planning of services. Br J Audiol 26(2):77–90
2. Drews CD, Yeargin-Allsopp M, Murphy CC, Decouflé P (1994) Hearing impairment among 10-year-old children: metropolitan Atlanta, 1985 through 1987. Am J Public Health 84(7):1164–1166
3. Fortnum H, Davis A (1997) Epidemiology of permanent childhood hearing impairment in Trent Region 1985–1993. Br J Audiol 31(6):409–446
4. Norton SJ, Gorga MP, Widen JE et al (2000) Identification of neonatal hearing impairment: evaluation of transient evoked otoacoustic emission, distortion product otoacoustic emission, and auditory brain stem response test performance. Ear Hear 21:508
5. Zamani A, Daneshjou K, Ameni A, Takand J (2004) Estimating the incidence of neonatal hearing loss. Acta MedicaIranica 42(3):176–180
6. Ayache S, Kolski C, Stramandinoli E, Leke A, Krim G, Strunski V (2001) Neonatal deafness screening with the evoked otoacoustic emissions technique. Ann otolaryngol chircervicofac 118(2):89–94
7. Vashistha I, Aseri Y, Singh BK et al (2016) Prevalence of hearing impairment in high risk infants. Indian J Otolaryngol Head Neck Surg 68:214
8. Gouri ZUH, Sharma D, Berwal PK, Pandita A, Pawar S (2015) Hearing impairment and its risk factors by newborn screening in north-western India. Matern Health Neonatol Perinatol 1:17
9. Nagapoornima P, Ramesh A, Rao S et al (2007) Universal hearing screening. Indian J Pediatr 74(6):545–549

10. John M, Balraj A, Kurien M (2009) Neonatal screening for hearing loss: pilot study from a tertiary care centre. Indian J Otolaryngol Head Neck Surg 61(1):23–26
11. Farhat AS, Ghasemi MM, Akhondian J, Mohamadzadeh A, Esmaeili H, Amiri R et al (2014) Assessment of the prevalence of hearing impairment in neonates born in Imam Reza, ghaem and OM-Albanin Hospitals of Mashhad. Iranian J Neonatol 5(2):17–20

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