

## Original Research Article

# Universal hearing screening in newborns: experience in a tertiary care hospital of Mangalore, Karnataka, India

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### ABSTRACT

**Background:** The aim of the study was to do universal hearing screening of all newborns using otoacoustic emission (OAE), to know the incidence and risk factors of hearing loss in neonates.

**Methods:** This was a prospective observational study done in a tertiary care hospital in Mangalore city in Karnataka. 950 neonates were screened with distortion product otoacoustic emission (DPOAE) during the study period of one year from 2017 to 2018. A repeat test was done at one and a half months of age if the first test failed. Auditory brain stem evoked response (ABER) was performed at 3 months of age if both the tests failed. Babies with hearing loss were referred to ENT specialist for further management. Comparison of the variables was done by student's t test and Chi-square test. P-value <0.05 was considered statistically significant.

**Results:** Out of the 950 newborns screened with DPOAE test, 204 (21.4 %) babies had abnormal screen either in single or both ears. 7 out of 204 (3.43%) babies had abnormal OAE on repeat testing at one and half months. 2 out of 7 babies (0.96 %) had significant hearing loss ABER was performed at 3 months of age.

**Conclusions:** Early identification by screening of hearing loss prevents a significant public health concern. Early recognition and intervention prior to 6 months have a significant positive impact on development.

**Keywords:** Auditory brain stem evoked response, Newborn hearing screening, Otoacoustic emission

### INTRODUCTION

Hearing defect is one of the most common occurring birth defects.<sup>1</sup> It occurs in 1 to 2 newborns per 1000 in the general population, and 24% to 46% of newborns admitted to neonatal intensive care unit (NICU).<sup>2</sup>

The function of hearing is very crucial for a child's development. Hearing impairment, both congenital and acquired has a devastating and detrimental impact on the development of newborn infants. Hearing impairment may result in lifelong deficits in speech and language acquisition, poor academic performance and personal-social and behavior problems.<sup>3</sup> Early identification of

hearing loss and appropriate intervention is necessary so that the auditory nervous system is stimulated during the time of brain plasticity (0-2 years). This will help the child to have a normal speech and communication as well as appropriate social, cognitive and academic development. In most of the countries across the world, newborn hearing screening programs have been implemented with varying success.<sup>4,5</sup> Many tertiary care centres in India have conducted OAE screening.<sup>6,7</sup> There is a national program in India known as National Programme for Prevention and Control of Deafness (NPPCD) but it has not been implemented in all the states. American academy of Paediatrics (AAP) and Indian Academy of Pediatrics (IAP) recommends 2 stage

screening-1<sup>st</sup> screen in all newborns for OAE before 1 month, to diagnose hearing loss before 3 months and to start intervention before 6 months. Screening should be universal and every new born to be screened.<sup>2,8</sup>

This study was undertaken to evaluate the possible burden of hearing loss among the neonates born in a tertiary care center and to justify the implementation of a universal hearing screening program in India.

## METHODS

This was a prospective observational longitudinal study conducted in AJ Institute of Medical Sciences, Mangalore. It is a medical college with a tertiary care hospital in Dakshina Kannada district of South India. There are around 1000 deliveries conducted per year in the hospital.

Sick newborns from all parts of the district and adjoining districts of Kerala are referred to the neonatal intensive care unit (NICU) here. The study was conducted between September 2017 to October 2018. All the neonates born in our hospital and those who were referred for newborn care during this period were enrolled in the study and screened for hearing loss as per recommendations of IAP consensus statement.<sup>2</sup>

They were divided into two groups - neonates with risk factors for hearing loss and those without risk factors using predetermined Joint Committee statement on infant hearing screening (JCIH) criteria which was as follows<sup>9</sup>:

- Intrauterine infection (TORCH)
- Craniofacial anomalies
- Birth weight less than 1500 gram
- Hyperbilirubinemia at a serum level requiring exchange transfusion
- Ototoxic medications used in multiple courses, or in combination with loop diuretics.
- Bacterial meningitis
- APGAR scores 0-4 at 1 minute or 0-6 at 5 minutes
- Mechanical ventilation for 5 days or longer
- Family history of hereditary childhood sensorineural hearing impairment
- Stigmata of other findings associated with a syndrome known to include sensorineural and/or conductive hearing loss.

### Exclusion criteria

- Failure to get parental consent.

After getting informed consent from parents newborns were subjected to OAE screening in both the ears.

DPOAE testing was done by a trained audiologist in a quiet room adjacent to the NICU. Otoread DPOAE screener (Interacoustic Ltd., Assens, Denmark) was used

and test was done free of cost. The Quick screen mode was used with a specially designed “stop” protocol that force discontinuation of the protocol when “pass” criteria was met. The clicks were delivered at a rate of 80 per second and timing window was 4 seconds. Stimuli consisted of standard transient clicks at 65 dB and 55 dB pSPL.

OAE was judged to be present and an ear to have “pass” when signal-to-noise ratio was at least 6dB in at least three of four frequency bands (1000, 2000, 3000, and 4000 Hz). A minimum of 60 successful sweeps was achieved in the test to be considered valid.

Screening continued until passing criteria were met or 1000 successful sweeps were occurring or for 10 min. If a baby failed an initial screen, it was repeated immediately after an effort to troubleshoot i.e. improve probe fit, clean probe contaminated by dust, decrease ambient noise, or change site of testing, calming baby by swaddling, rocking, and eating. An acceptable screen was done but once for each ear.

A repeat DPOAE screening test was done at one and a half months of age if the first test before discharge failed. ABER was performed at 3 months of age for those who had failed DPOAE screening for the second time. was done by a trained audiologist and was done free of cost under conditions of natural sleep using an Evomatic 4000 evoked potential unit (Medtronic, Minneapolis, MN), a standard Ag/AgCl electrode applied on the forehead and each mastoid, and pediatric insert earphones coupled to Etymotic ER3A stimulators (Etymotic Research, Elk Grove, IL).

Stimuli consisted of 100- millisecond rarefaction clicks, and tone pips presented at a rate of 25 per second for at least 1000 presentations with alternating triggering to permit both ears to be examined simultaneously. Our cutoff values of normal were 23 to 26 dB for observable wave V for clicks and 30 dB NHL for tone pips. Babies with hearing loss were referred to ENT specialist for further management and speech and audiology department for hearing aid.

### Statistical analysis

Statistical analyses were performed using the SPSS software version 23 for data analysis. Comparison of the variables was done by student's t test and Chi-square test. P value less than 0.05 was considered significant.

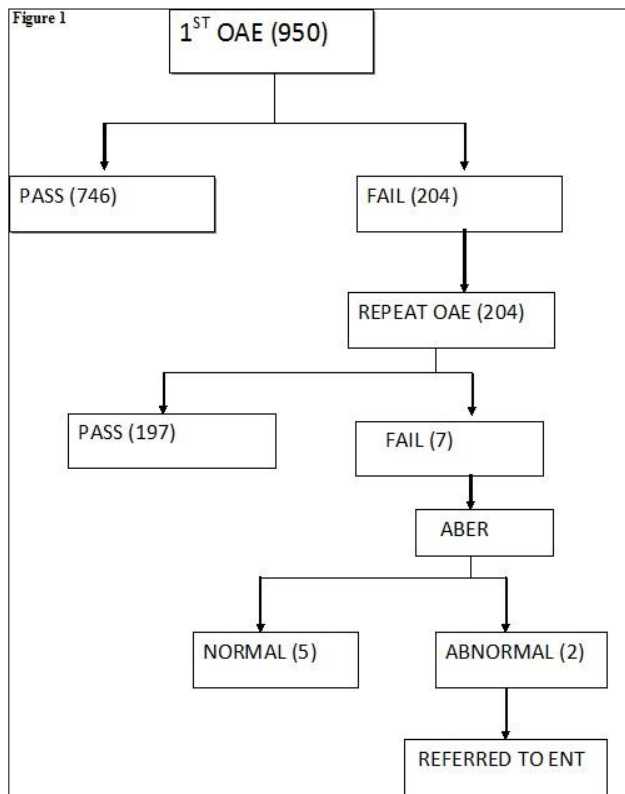
## RESULTS

Out of 950 babies who were screened, 502 were males and 448 were females. 56 (5.89%) babies were premature and 103 (10.8%) were low birth weight (LBW) babies. (Table 1 ). With maternal risk factors alone, authors had 69 babies in present study.

**Table 1: Demographic data of the study population.**

Demographic parameter	With maternal risk factor	Without maternal risk factor	Total
<b>Gestational age</b>			
<32 weeks	0	2	2
32-34 weeks	3	6	9
34-37 weeks	4	41	45
>37 weeks	62	832	894
<b>Gender</b>			
Male	40	462	502
Female	29	419	448
<b>Birth weight</b>			
>2.5kg	52	795	847
1.5-2.49kg	15	79	94
1-1.49kg	1	7	8
<1kg	1	0	1

Out of 950 babies screened (Figure 1), initial DPOAE was absent in 204 for whom repeat DPOAE was performed at age of one and a half months of age. Of which 7 had abnormal DPOAE for whom ABER was performed at 3 months of age and referred to ENT specialist for further management.



**Figure 1: Screening of 950 babies.**

481 babies (50.63%) had risk factors for hearing impairment. Illness or condition requiring admission NICU stay of 24 hours, LBW, prematurity, maternal risk factors were the major risk factors in our study population (Table 2). In the initial screening of 950

neonates by DPOAE, 204 (21.4 %) had abnormal screen either in single or both ears (Table 3).

**Table 2: Potential risk factors.**

Risk factors	Frequency	%
Prematurity	56	5.89
Low birth weight	103	10.8
Assisted ventilation	7	0.73
Low Apgar	4	0.42
Severe jaundice (s. bilirubin > 20mg/dl )	40	4.2
Maternal illness during pregnancy	69	7.26
Illness or condition requiring admission NICU stay >24h	156	16.42
Meningitis	1	0.1
Sepsis positive blood cultures	3	0.31
Craniofacial anomalies	2	0.21
Syndromes	3	0.31
CHD	6	0.63
Aminoglycoside use	31	3.26
Total	481	50.63

**Table 3: Results of initial screening with DPOAE in the study population.**

Result	Frequency	%
Bilateral pass	746	78.5
Unilateral pass	32	3.4
Bilateral fail	172	18.1
Total	950	100.0

**Table 4: Results of 2<sup>nd</sup> DPOAE in the study population.**

Result	Frequency	%
Bilateral pass	197	96.5
Unilateral pass	4	2.0
Bilateral fail	3	1.5
Total	204	100

7 out of 204 (3.4%) had abnormal DPOAE done at age of one and a half months of age (Table 4). ABER was performed for these babies at 3 months of age and 2 (28.5%) significant hearing loss. Both the babies had moderate hearing loss ( Vth peak present till 70 dB) in the right ear and mild hearing loss ( Vth peak present till 50 dB) in the left ear.(Table 5).

**Table 5: Results of ABER in neonates who failed repeat DPOAE testing.**

Result	Frequency	%
Normal	948	99.8
Right moderate hearing loss and left mild hearing loss	2	0.2
Total	950	100

## DISCUSSION

In the present study, authors screened 950 newborns by DPOAE followed by ABER in those who had abnormal DPOAE. Both DPOAE and ABER are quick, non-invasive studies and each method assesses hearing differently. DPOAE was used as the first screening tool due to its feasibility and cost effectiveness. The first screening done by DPOAE had a referral rate of 204(21.4%). This is comparable to the study done in Chennai by Vignesh et al.<sup>10</sup> The referral rate of DPOAE can vary from 11-31% as reported by Barker et al as comparable to our study.<sup>11</sup> This variation could be because of criteria applied for pass/ refer. OAE measures sound waves generated in the inner ear in response to the tone bursts or clicks emitted and recorded through miniature microphones placed in the external ear canal of the infant. Although OAE screening is quicker and easier to perform than ABER, it may get affected by fluid or debris in the external or middle ear. Due to this a second screening by DPOAE was done at one and a half months of age. The referral rate reduced to 7 (3.43%) in the second screen which is comparable to study done by John et al initial referral rate of 6.4% was reduced to 1.6% on repeat testing.<sup>12</sup> 2 out of 7 babies had abnormal ABER when they were evaluated at three months of age. The incidence of hearing loss in our study was 0.21% (2/1000 live births) which is similar to the world-wide prevalence of 1-2 per 1000 live births.<sup>13,14</sup> One newborn was 32 weeks preterm LBW with culture proven sepsis and meningitis with risk factor of aminoglycoside usage for >7days. The second neonate was 34 weeks late preterm LBW with no maternal risk factors. The baby had sepsis and required aminoglycoside use for >7 days and needed ventilator support and NICU stay for 20 days. Both the babies were advised for hearing aid after confirming hearing loss with ABER by ENT specialist. In the present study, out of 950 babies screened, 481(50.63%) had risk factors and 469 (49.37 %) didn't have any risk factors. History of illness or condition requiring admission NICU stay of >24h, low birthweight, maternal risk factors (hypothyroidism, PIH, gestational diabetes mellitus), severe jaundice and aminoglycoside use > 7 days were significant risk factors. which comparable to similar finding in study done by Gouri et al and Nagapoornima et al.<sup>15,16</sup> In our study authors also observed that 13 babies out of 469 who didn't had any risk factors also had absent OAE in the initial DPOAE screening. Repeat OAE screening showed normal in these babies. Hence every baby has to be screened for OAE irrespective of risk factors being present or not.

Since OAE is quick, cost effective and compared to ABER, retesting with OAE makes the universal screening programme more sustainable especially when there are large numbers of newborns in a developing country like India. Two step screening is carried out easily and more feasible. Though this two-step screening may miss out auditory neuropathy spectrum disorders, it is sensitive in

identifying sensory neural and conductive hearing loss at early stage.

## CONCLUSION

Universal hearing screening with OAE followed by ABER is recommended for early recognition of hearing impairment. Since OAE has a high referral rate, it should be repeated when it fails, and babies should be referred for ABER when the results are abnormal twice.

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