ORIGINAL ARTICLE

Neonatal Hearing Screening Using Transient Evoked Otoacoustic Emissionsin Gulab Devi Teaching Hospital

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ABSTRACT

Objective: The objective of the study is to determine the prevalence of hearing loss through the Universal Neonatal Hearing Screening Program.

Study Design: An analytical cross–sectional study.

Place and Duration of Study: Newborn Nursery of Pediatric Department of Gulab Devi Teaching Hospital from February 2023 to December 2023.

Material and Methods: The study was performed on the sample size of 712 neonates. Non-probability sampling techniques were used in this study. All healthy neonates discharged from Hospital were included in this study. Neonates with any medical conditions were excluded. The SPSS version 23.0 package was used for statistical analysis. Frequencies and percentage were used to report qualitative variables such as age, gender and results of hearing screening.

Results: Total sample size of was 712, out of which 381 (53.5%) were male and 331 (46.5%) were female. Both ears of 501(70.4%) neonates were pass and 211 (29.6%) were referred. Out of referred ears 182 (25.6%) were due to noise. The ears of 590 (82.9%) subjects were tested after 24 hours and ears of 122 (17.1%) were tested within 24 hours. Only 34 (4.8%) patients visited after 4 weeks for follow-up, out of which 24(3.3%) passed hearing screening and 10 (1.4%) were referred.

Conclusion: Our study shows high “pass” percentage and low ‘referral’ percentage for universal newborn hearing screening as well as in follow-up cases. A large number of neonates were “referred” due to noisy test environment and on whom tests were performed before 24 hours of age as there could be possibility of physiological changes and debris in the ear canal etc.

Key Words: *Hearing impairment, TEOAE’s, Neonatal screening*.

INTRODUCTION

Otoacoustic emissions (OAEs) represent the acoustic response as emitted by the cochlea and are influenced by the contractile activity of external ciliate cells, as well as the mechanical and structural characteristics of the basilar membrane. They serve as objective indicators of cochlear health.[1] OAEs can be categorized as either spontaneous (SOAEs) or evoked by acoustic stimulation (EOAEs).[2] Transient Evoked

Otoacoustic Emissions (TEOAE) are generated by a brief stimulus, typically a click, while Distortion Product Otoacoustic Emissions (DPOAE) are elicited by two pure tones of slightly differing frequencies continuously presented to the ear.[3.]

Transient evoked otoacoustic emissions (TEOAEs) have become the preferred method of neonatal audiological screening due to their reproducibility, diagnostic accuracy, ease of administration and minimally invasive nature.[4.]Recent modifications have been proposed to enhance the quality of TEOAE recording methods. In contrast the utilization of neonatal screening through distortion product analysis (DPOAE) is still limited or in its preliminary stage.[5]

When significant hearing impairment in infants goes undetected and untreated, it can have profound and adverse effects on their speech and language development.[6] This can result in difficulties such as dysgrammatism, poor language skills, and various psychological and behavioral disorders.[7] Furthermore, untreated hearing impairment can lead to a decline in intellectual abilities and have a negative impact on the individual's socioeconomic status. Early detection and intervention are crucial to mitigate these potential challenges and ensure a better quality of life for affected individuals.[8]

Currently, hearing loss is considered the most prevalent congenital anomaly.[9] The occurrence of moderate to severe bilateral Sensorineural hearing loss, with a threshold greater than 50 decibels nHL, varies from 1.2 cases per 1,000 healthy newborns to 2-4.5% in high-risk newborns.[10] More than 50% of cases of congenital sensorineural hearing loss are attributed to genetic factors.[11]

Ideally, newborns with congenital hearing loss should be identified within the first three months of life, but the current average age at detection stands at 24 to 30 months.[12] Despite international recommendations advocating for it, universal neonatal hearing screening for congenital hearing loss has not yet been widely implemented.[13]

Our study aims to determine the incidence of hearing loss through the Universal Neonatal Hearing Screening Program utilizing TEOAE. Children who were identified early and received intervention services within their first year of life exhibited significantly enhanced vocabulary, syntax measured by mean length of utterance, phoneme repertoires, social-emotional development, speech intelligibility, general language abilities parental bonding, and parental grief resolution.

MATERIAL AND METHODS

The study was performed in Al-Aleem Medical College, Gulab Devi Teaching Hospital, Lahore and approved by institutional review board vide no. AAMC/IRB/EA36/2024 dated 24th April, 2024 on the sample size of 712 neonates. Non-probability sampling techniques were used in this study. Data was collected from newborn nursery of Gulab Devi Teaching Hospital from February 2023 to December 2023. All healthy neonates discharged from hospital were included in this study. The neonates with any other medical conditions were excluded. The neonates were screenedfor hearing by using TEOAE's with ERO SCAN (MAICO) equipment, within 48 hours of birth to find out the incidence of hearing impairment. Patients who passed the screening were discharged from hospital, and those who were referred called for follow-up after 4 weeks. ERO SCAN offers frequency specific TEOAE's. The ERO SCAN, featuring a sharp organic LED display, showcases line and bar diagrams, facilitating direct evaluation. This device offers automated tests employing two transiently evoked otoacoustic emissions (TEOAE) screening protocols, making it ideal for hearing screening programs. With a quick assessment of the auditory system up to the cochlea, it yields outcomes of "Pass" or "Refer". A "Pass" result indicates hearing levels better than 30dB, while a "Refer" indicates hearing levels worse than 30dB. Results are stored on the equipment and later transferred to a computer for analysis. Furthermore, mothers of all infants received counseling on the benefits of hearing screening, test procedures, the importance of follow-up, additional tests if the neonate failed the screening, and available interventions if hearing loss was confirmed. Collected data was entered into an SPSS spreadsheet. The SPSS version 23.0 package was used for statistical analysis. Frequencies and percentage were used to report qualitative variables such as age, gender and results of hearing screening.

RESULTS

TABLE 1: Gender analysis

Gender	Number	Percentage
Male	381	53.5
Female	331	46.5
Total	**712**	**100.0**

Table 1 shows male and female percentage. Out of total number 712, 381 (53.5%) were male and 331 (46.5%) were female.

TABLE 2: Demographic distribution

District	Number	Percentage
Kasur	148	20.8
Lahore	509	71.5
Narowal	24	3.4
Sheikhupura	12	1.7
Okara	5	0.7
Gujrat	5	0.7
Sargodha	4	0.6
Nankana Sahab	4	0.6
Muzzafargarh	1	0.1
Total	**712**	**100.0**

Table 2 shows demographic distribution. Out of 712 neonates, 509 (71.5%) were from Lahore and 148 (20.8%) Kasur. Other were from different cities of Punjab i.e 24 (3.4%) from Narowal, 12 (1.7%) Sheikhupura, 5 (0.7%) Okara, 5 (0.7%) Gujrat, 4 (0.6%) Sargodha, (0.6%) Nankana Sahab and 1 (0.1%) Muzzafargarh.

TABLE 3: Screening outcome

Status	Number	Percentage
Pass	501	70.4
Refer	211	29.6
Refer due to Noise	182	25.6
Total	**712**	**100.0**

Table 3 shows frequency and percentage of neonatal hearing screening test. Out of Total 712 subjects 501 (70.4%) were pass and 211 (29.6%) refer. Referred subjects due to noisy environment were 182 (25.6%).

TABLE 4: Status regarding subjects age

Status	Number	Percentage
Ears Tested within 24 hours of age	122	17.1
Ears Tested after 48 hours of age	590	82.9
Total	**712**	**100.0**

Table 4 shows 590(82.9%) were tested within 24 hours of age and 122 (17.1%) after 24 hours of age.

TABLE 5: Follow-up patients

Status	Number	Percentage
Follow-up Patients	34	4.8
Pass	24	3.4
Refer	10	1.4
Total	**712**	**100.0**

Table 5 shows 34 neonates (4.8%) visited for follow-up after 4 weeks for screen. 24 (3.3%) were pass and 10 (1.4%) were refer.

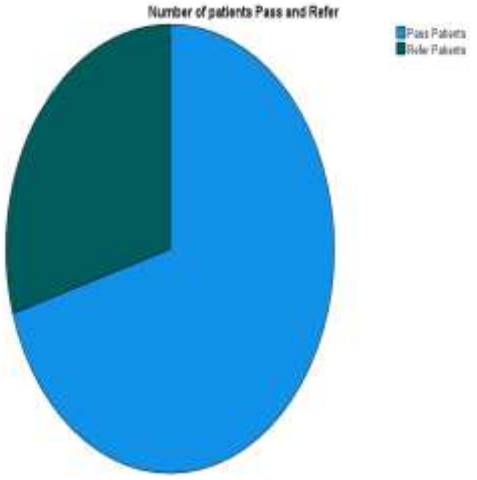

Fig 1: Number of patients (Pass and Refer)

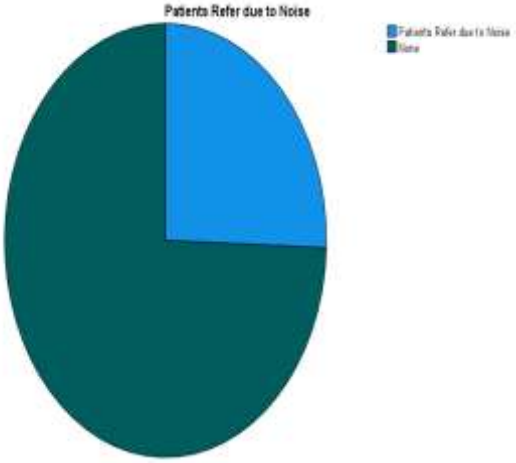

Fig 2: Patients refer due to noise

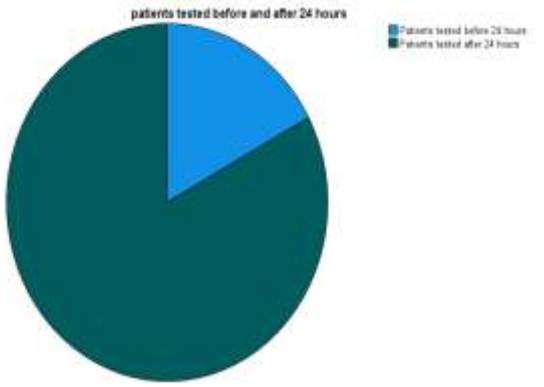

Fig 3: Patients tested before and after 24 hours

Overall table 1 shows the percentage of male and female and Out of total number 712, 381 (53.5%) subjects were male and 331 (46.5%) subjects were female. Table 2 shows demographic distribution. Out of 712 neonates, 509 (71.5%) were from Lahore and 148 (20.8%) Kasur. Other were from different cities of Punjab i.e 24(3.4%) from Narowal, 12 (1.7%) Sheikhupura, 5 (0.7%) Okara, 5 (0.7%) Gujrat, 4 (0.6%) Sargodha, (0.6%) Nankana Sahab and 1 (0.1%) Muzzafargarh. Table 3 shows the frequency and percentage of neonatal hearing screening test. Out of total 712 subjects 501 (70.4%) neonates were pass and 211 (29.6%) neonates were refer. Referred subjects due to Noisy environment were 182 (25.6%). Table 4 shows 590 (82.9%) neonates were tested within 24 hours of age and 122 (17.1%) neonates after 24 hours of age and final table 5 shows 34 neonates (4.8%) visited for follow-up after 4 weeks for screen. 24 (3.3%) subjects were pass and 10 (1.4%) subjects were refer.

DISCUSSION

The results of our study shows high “pass “and low ‘refer’ percentage for universal newborn hearing screening in our tertiary care set-up. A large number of neonates were “refer” due to noisy test environment and tested within 24 hours after birth as there could be some physiological changes or some debris in the ear canal etc. The problem that was detected in the study is that most of “refer” patients did not turn for follow-up. The poor follow-up of patients can be due lack of tracking systems, and lack of audiology services at gross root level and lack of awareness. Additionally, distant hospital approach, non-specific parental worries and stress, procedural challenges, and insufficient accessibility and awareness of services have been identified.

In a recent study conducted in Saudi Arabia by Noura Alothman and published in January 2024, 214,971 births were reported by the UNHS Program National Registry. Among these, 199,034 newborns underwent screening, representing a participation rate of 92.6%. The initial screening yielded a pass rate of 96.4%, with 191,194 newborns passing. The referral rate for further evaluation of one or both ears was 3.6%, comprising 7,840 newborns. Of these, 43.5% (3,412 newborns) passed the second screening stage, while 56.5% (4,428 newborns) did not and were scheduled for a third screening. Among those who failed the second screening, 6.2% (274 newborns) passed the third screening, while the remaining 93.8% (4,154 newborns; 2,266 in one ear and 1,888 in both ears) were referred for diagnostic audiologic assessment.[14]

Allison Mackey conducted another study in February 2021 to evaluate the effectiveness of newborn hearing screening programs. Among 47 countries or regions, data on NHS coverage rates were available from 26, referral rates from 23, follow-up rates from 12, and detection rates from 13. The median coverage rate for the initial screening step was reported as 96%. Referral rates from this step ranged from 6% to 22% for screenings conducted within 24 hours of birth, 2% to 15% for screenings after 24 hours, and 4% for screenings after 72 hours. Referral rates for diagnostic assessment averaged 2.1% after one to two steps using OAE only, 1.7% after two steps involving ABR, and 0.8% after three to four steps including ABR. The median detection rate for bilateral permanent hearing loss greater than 40dB was 1 per 1000 infants.[15]

In 2011, George X. Papacharalampous published a study aiming to compile current evidence on the efficacy and outcomes of universal hearing screening programs. The study selection process involved evaluating the protocols utilized and assessing their effectiveness in early diagnosing congenital hearing impairment. Across the 20 studies analyzed, a total of 676,043 screened children were identified. The average initial

referral rate across these studies was 3.89%. Among these studies, five (covering 107,560 children) utilized transiently evoked otoacoustic emissions (TEOAEs), two (encompassing 15,382 children) used automated auditory brainstem response (a-ABR), and the remaining 13 (with 564,180 children) employed both screening protocols. The number of screened children ranged from 1,421 to 148,240, while the initial referral rate varied from 0.6% to 16.7%. The cases identified with hearing loss as the final outcome of the investigation changes from 0.038% to 0.517%, and the rates of lost-to-follow-up ranged from 3.7% to 65%.[16]

In our study out of a total 712 neonates 501 (70.4%) were pass bilaterally and 211 (29.6%) were refer. Out of refer subjects,182 (25.6%) were due to noisy situation. Only 34 (4.8%) patients turned up for follow-up after 4 weeks for second screen, out of which 24 (3.3%) were pass and 10 (1.4%) were refer.

Limitations: Limitations of our study was that most of "refer" patients did not turn for follow-up. From a clinical perspective, inadequate follow-up undermines the efficacy of early hearing loss detection and, consequently, the provision of timely intervention.

CONCLUSION

This study shows high "pass "and low 'refer' percentage for universal newborn hearing screening in our tertiary care set-up as well as in follow-up cases. A large number of neonates were "refer" due to noisy test environment and tested within 24 hours of the birth as there could be some physiological changes or some debris in the ear canal etc.

Conflict of interest: None

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