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Research Article

Early Detection of Neonatal Hearing Impairment: Timely Intervention for Optimal Outcomes

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ABSTRACT

Background: Hearing impairment in neonates can significantly impact speech, language, and cognitive development. Early detection through screening allows timely intervention, improving developmental outcomes.
Objectives: To assess the prevalence of neonatal hearing impairment and evaluate the effectiveness of early screening using Otoacoustic Emissions (OAE) and Auditory Brainstem Response (ABR) tests.
Methods: A prospective observational study was conducted on 300 neonates born in a tertiary care center. Neonates were screened using OAE within 48–72 hours of birth, with ABR performed for those who failed initial OAE. Demographic data, perinatal risk factors, and screening outcomes were collected. Statistical analysis included Chi-square tests for associations between risk factors and hearing impairment.
Results: Out of 300 neonates, 24 (8%) failed initial OAE screening. ABR confirmed hearing impairment in 15 neonates (5%). Significant risk factors included prematurity, low birth weight, neonatal jaundice, and birth asphyxia. Early intervention with hearing aids and cochlear implants led to improved auditory responses in follow-up assessments.
Conclusion: Universal neonatal hearing screening enables early detection and timely intervention, significantly improving auditory and developmental outcomes. Implementation of structured screening programs is recommended.

Keywords: *Neonatal hearing impairment, Otoacoustic emissions, Auditory Brainstem Response, Early intervention, Screening.*

INTRODUCTION

Hearing is one of the most critical senses required for normal communication, speech, and language development. The neonatal period is a crucial window for auditory stimulation, which significantly influences cognitive, social, and emotional development. Hearing impairment identified late can result in delays in speech, language, literacy, and psychosocial development, which may persist throughout life.

Globally, the prevalence of neonatal hearing impairment ranges from 1 to 3 per 1000 live births in healthy newborns and up to 2–4% in neonates admitted to intensive care units. In India, the prevalence is reported to be higher in high-risk populations due to factors like prematurity, low birth weight, neonatal jaundice, infections, and perinatal hypoxia. Despite this, universal neonatal hearing screening is not yet widely implemented, resulting in delayed diagnosis and suboptimal outcomes.

Several perinatal risk factors have been associated with neonatal hearing impairment, including prematurity, low birth weight (<2.5 kg), hyperbilirubinemia requiring exchange transfusion, birth asphyxia (Apgar score <6 at 5 minutes), exposure to ototoxic drugs (such as aminoglycosides or loop diuretics), NICU admission, and craniofacial anomalies. Early identification of these risk factors allows clinicians to focus on targeted screening and timely referral for intervention.

Screening Techniques:

1. Otoacoustic Emissions (OAE): OAE measures sound waves produced in the inner ear (cochlea) in response to auditory stimuli. It is non-invasive, quick, and highly sensitive for detecting cochlear dysfunction.

2. Auditory Brainstem Response (ABR): ABR measures neural activity in the auditory nerve and brainstem in response to sound stimuli. ABR is the gold standard for confirming hearing loss and differentiating between sensory and neural deficits.

Importance of Early Intervention:
Early intervention for hearing impairment (before 6 months of age) with hearing aids or cochlear implants improves auditory perception, speech, and language development. Studies show that children receiving timely intervention achieve near-normal language milestones, while those identified later show persistent delays.

Rationale:
Despite its importance, neonatal hearing screening is not routinely practiced in many Indian hospitals. This study aims to evaluate the prevalence of hearing impairment among neonates in a tertiary care hospital, identify associated risk factors, and highlight the effectiveness of early intervention in optimizing outcomes.

Materials and Methods
Study Design: Prospective observational study

Setting: Department of Otorhinolaryngology, Adesh Medical College and Hospital, Ambala

Duration: September 2023 – April 2025

Sample Size: 300 neonates

Inclusion Criteria:
- All neonates born in the hospital
- Written informed parental consent

Exclusion Criteria:
- Neonates with congenital ear anomalies
- Critically ill neonates not suitable for screening

Screening Protocol:
- OAE Screening: Performed within 48–72 hours of birth using a portable OAE machine. Neonates with "pass" were considered normal; those with "refer/fail" were rescreened after 1–2 weeks.
- ABR Confirmation: Neonates failing OAE underwent ABR testing to confirm hearing impairment.

Data Collected:
- Demographic details: gender, gestational age, birth weight
- Perinatal risk factors: prematurity, low birth weight, neonatal jaundice, birth asphyxia, NICU stay, maternal infections
- Screening outcomes: OAE pass/fail, ABR confirmation
- Follow-up outcomes: improvement after hearing aids/cochlear implant

Statistical Analysis:
- Data analyzed using SPSS software
- Categorical variables presented as frequency and percentages
- Chi-square test used to assess association between risk factors and hearing impairment
- p-value <0.05 considered statistically significant

Ethical Considerations:
- Study approved by Institutional Ethics Committee
- Parental consent obtained for all neonates

Results
- Demographic and Clinical Characteristics:

Parameter	Number (%)
Male	160 (53.3%)
Female	140 (46.7%)
Full-term	240 (80%)
Preterm	60 (20%)

Parameter	Number (%)
Normal birth weight	220 (73.3%)
Low birth weight (<2.5kg)	80 (26.7%)

Risk Factors Associated with Hearing Impairment

Risk Factor	Number of neonates	Hearing Impairment (%)
Prematurity	60	5
Low birth weight	80	6
Neonatal jaundice	50	4
Birth asphyxia	30	3

Screening Outcomes:

Screening Test	Number (%)
Passed OAE	276 (92%)
Failed OAE	24 (8%)
Confirmed Hearing Loss (ABR)	15 (5%)

Follow-up Outcomes:

- All neonates diagnosed with hearing impairment were referred for early intervention.
- Hearing aids were provided to 10 neonates, and cochlear implants were advised for 5 neonates with severe impairment.
- Follow-up over 6 months showed improved auditory response in 12 neonates and partial improvement in 3 neonates.

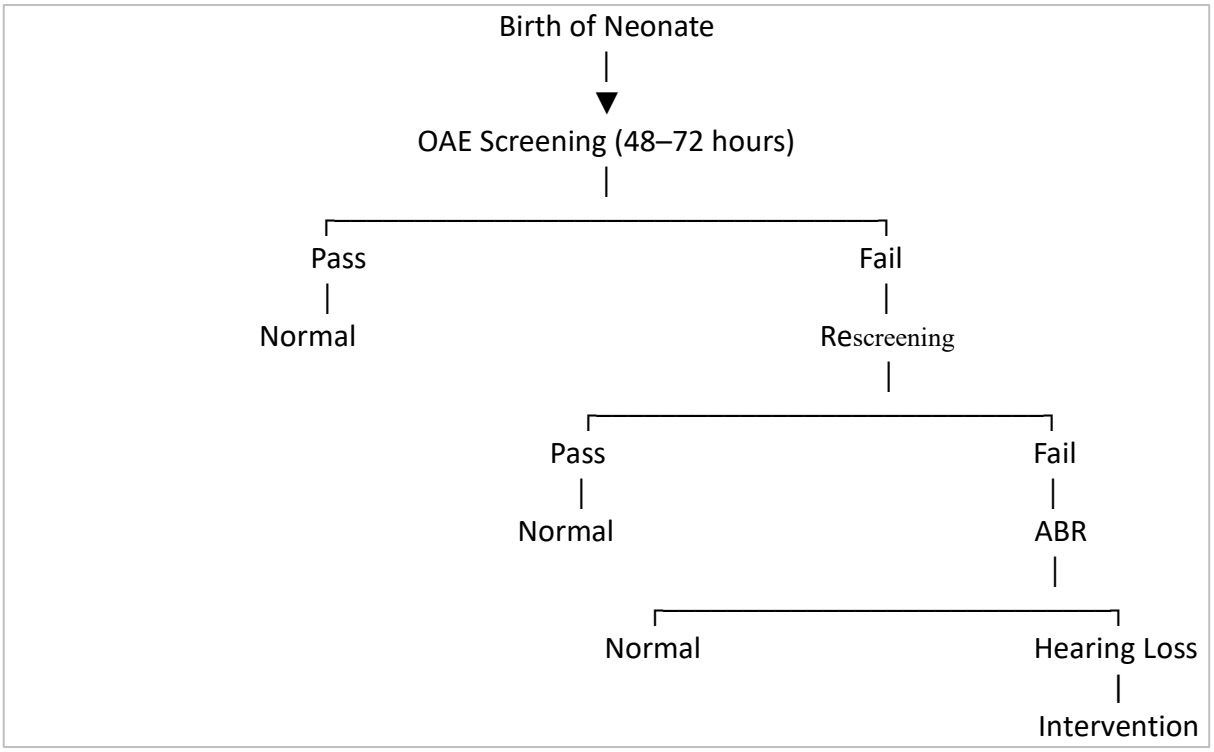

Figure 1: Flow chart of neonatal hearing screening (OAE → ABR → Intervention)

Discussion

Hearing impairment in neonates is a significant public health concern, affecting communication, speech, and cognitive development. In this study, 5% of neonates were confirmed to have hearing impairment, which is higher than the global prevalence (1–3 per 1000) but consistent with high-risk populations such as NICU-admitted neonates.

Risk Factors:

Prematurity and low birth weight were the most significant contributors. Neonates with hyperbilirubinemia and birth asphyxia were also at higher risk. These findings align with previous studies reporting higher prevalence in neonates with perinatal complications.

Screening Tools:
OAE proved effective as a first-line screening method due to its non-invasive nature, rapid execution, and high sensitivity. ABR served as a confirmatory test to accurately diagnose hearing impairment. The two-step screening protocol ensured early identification while minimizing false positives.

Importance of Early Intervention:
Early rehabilitation using hearing aids or cochlear implants significantly improved auditory responses and developmental outcomes. Literature suggests that intervention before 6 months of age maximizes language acquisition potential. Speech therapy and audiological monitoring further enhanced outcomes.

Comparison with Literature:
- Olusanya et al. (2008) reported a prevalence of 4–6% in high-risk Indian neonates.
- Kennedy et al. (2004) emphasized the role of universal newborn hearing screening in reducing developmental delays.
- JCIH (2019) guidelines recommend screening by 1 month, diagnosis by 3 months, and intervention by 6 months.

Challenges:
- Resource limitations for universal screening in developing countries
- Lack of parental awareness
- Difficulty in follow-up for neonates discharged early

Recommendations:
- Universal neonatal hearing screening programs should be implemented nationwide.
- High-risk neonates must receive targeted follow-up.
- Government and institutional policies should fund screening equipment and training of audiologists.

Limitations:
- Single-center study
- Relatively short follow-up duration
- Limited sample size

Conclusion
Neonatal hearing impairment is underdiagnosed without routine screening. A two-step screening protocol using OAE followed by ABR effectively identifies affected neonates. Early intervention with hearing aids or cochlear implants significantly improves auditory and developmental outcomes. Structured screening programs and awareness campaigns are critical to prevent long-term communication deficits.

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