Section: Pediatrics

Research

STUDY OF RELIABILITY OF AABR COMPARED TO FOLLOW UP BERA IN EARLY DETECTION OF SENSORY NEURAL HEARING LOSS IN PRETERMS AND HIGH-RISK NEWBORNS

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Abstract

Background: Hearing assessment in newborns is one of the grey areas in the field of medicine as the clinical tests and investigations for assessing hearing loss in newborns are a little cumbersome and most practicing pediatricians are not very conversant with these procedures. Present study was aimed to assess the reliability of AABR compared to follow up BERA in early detection of sensory neural hearing loss in preterms and high-risk newborns. **Materials and Methods:** Present study was single-center, retrospective, descriptive study, conducted in neonates who admitted in NICU, with gestational age < 35 weeks and all term newborns with high risk factors such as ventilation > 5days, severe hyperbilirubinemia (SBR>20mg/dl), requiring exchange transfusion, requiring cooling, birth asphyxia, seizures, meningitis, aminoglycoside and diuretics exposure, etc. Screening AABR at discharge (whether Normal or Abnormal) was compared to the result of followup BERA after 3 months. **Result:** In present study, among 559 neonates, majority were male babies (61.9 %), had birthweight 1.5– 2.5kg (44.5 %) & had gestational age between 32- 37wks (51.2 %). Sensitivity and Specificity of screening AABR when compared to BERA as gold standard is 93.7% and 96.5% respectively. The Positive predictive value and the Negative predictive value of screening AABR is 75% and 98.5% respectively. **Conclusion:** Neonates with risk factors such as hyperbilirubinemia (SBR>20mg/dl), who underwent exchange transfusion, exposure to ototoxic drugs, ventilation >5 days, birth asphyxia and meningitis have shown greater risk of hearing loss. AABR is good screening test for hearing loss in high-risk newborns.

INTRODUCTION

Hearing assessment in newborns is one of the grey areas in the field of medicine as the clinical tests and investigations for assessing hearing loss in newborns are a little cumbersome and most practicing pediatricians are not very conversant with these procedures.[1]

Newborns that survive perinatal events are prone to manifest developmental issues such as neurological and/or sensory deficits. This possibility increases as birth weights and gestational ages decrease, which characterizes this population as an at-risk group for neurological or sensory disorders, including peripheral and/or central hearing disorders.[2,3,4]

Early detection and rehabilitation of hearing loss produces worthwhile benefit in terms of improved speech and language provides the rationale for the universal screening of neonates and infants across the world.[5] The detection threshold targeted by newborn hearing screening is 40 dBnHL in India and is performed bilaterally. The screening methods used in all countries are transient evoked otoacoustic emissions (TEOAE) testing and automated auditory brainstem response (AABR), with distortion product otoacoustic emissions (DPOAE) testing also used in some countries.[6]

The brainstem auditory evoked response (BERA) appears exceptionally well suited for and is the satisfactory procedure which can be performed with ease in children.[7] Present study was aimed to assess the reliability of AABR compared to follow up BERA in early detection of sensory neural hearing loss in preterms and high risk newborns.

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MATERIALS AND METHODS

Present study was single-center, retrospective, descriptive study, Conducted in NICU of the department of Pediatrics at Government Medical College, Suryapet, Telangana. Study duration of 2 years (May 2020 to May 2022) Study approval was obtained from institutional ethical committee.

Inclusion Criteria

- All neonates who admitted in NICU, with gestational age < 35 weeks and all term newborns with high risk factors such as ventilation > 5days, severe hyperbilirubinemia (SBR>20mg/dl), requiring exchange transfusion, requiring cooling, birth asphyxia, seizures, meningitis, aminoglycoside and diuretics exposure, etc.

Exclusion Criteria

- Neonates with gestational age > 35 weeks with no risk factors
- Neonates with fetal anomalies
- Deaths and LAMAs in NICU
- Babies for whom AABR has not done
- Newborns with family history of childhood hearing loss

Electronic medical records of neonates considered for study were analysed, variables collected included patients gender, gestational age, birth weight, ventilation days, highest SBR, aminoglycoside and diuretics use, Neurosonogram, seizures, meningitis/ventriculitis, exchange transfusion and therapeuting hypothermia if any.

Screening AABR at discharge (whether Normal or Abnormal) was compared to the result of followup BERA after 3 months. The data was entered into MS -Excel with all built in checks, data analysis was carried out using the statistical package for social sciences (SPSS 20th version). The results were expressed as % frequency distribution for categorical variables between the two groups of AABR and BERA. The diagnostic tests like sensitivity, specificity, PPA and NPA between AABR and BERA was also evaluated. The odds ratios were also computed for some of the risk factors using Med cal C software. A two tailed p - value of <0.05 was used to determine the statistical significance in all cases.

RESULTS

In present study, among 559 neonates, majority were male babies (61.9 %), had birthweight 1.5–2.5kg (44.5 %) & had gestational age between 32-37wks (51.2 %).

Prevalence of hearing loss in screening (Abnormal AABR) in the study population was 4.11% (n=23). Percentage of hearing loss (abnormal AABR) in babies <1.5 kg was 4.6 % and in babies 1.5 – 2.5 kg was 3.6%. The odds of developing hearing loss in babies <1.5 kg was 1.29 and (p=0.6). This implies that those babies <1.5 kg were 29% higher risk of developing hearing loss when compared to those with babies between 1.5kg – 2.5kg.

Percentage of hearing loss (abnormal AABR) in babies <32 wks was 6% and in babies 32 – 37 wks was 3.6%. The odds of developing hearing loss in babies <32 wks was 2.56 and (p=0.06). This implies that those babies <32 wks were 2.5 times higher risk of developing hearing loss when compared to those with babies between 32wks – 37wks.

Table 1: General characteristics

	No. of cases (n=559)	Percentages
Sex		
Male	346	61.90%
Female	213	38.10%
Birth weight		
<1.5 kg	173	30.95%
1.5 to 2.5kg	249	44.54%
>2.5kg	137	24.51%
Gestational age		
<32 wks	149	26.65%
32-37 wks	286	51.16%
>37 wks	124	22.18%

Table 2: AABR results

	AABR result		P value	Odds Ratio (Upper limit - Lower limit)
	Normal (n=536)	Abnormal (n=23)		
Birth weight			0.6	1.29 (0.48 - 3.42)
<1.5 kg (n=173)	165 (95.3)	8 (4.6)		
1.5- 2.5kg (n= 249)	240 (96.3)	9 (3.6)		
>2.5 kg (n=137)	131 (96)	6 (4)		
Gestation age			0.06	2.56 (0.93 - 7.02)
<32 wks (n=149)	140 (93.9)	9 (6)		
32-37 wks (n= 286)	279 (97.5)	7 (2.4)		
>37 wks (n=124)	117 (94.3)	7 (5.6)		

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Follow-up BERA was done in 161 neonates. Abnormal BERA findings were, mild hearing loss is (3.7 %), moderate hearing loss (2.48 %) and severe hearing loss (3.72 %). In Normal AABR group (n=141),the percentage of normal BERA was 99.2% (n=140) and abnormal BERA with Mild hearing loss was 0% (n=0), Moderate hearing loss was 0.7% (n=1) and Severe hearing loss was 0% (n=0). In Abnormal AABR group (n=20), the percentage of normal BERA was 25% (n=5) and abnormal BERA with Mild hearing loss was 30% (n=6), Moderate hearing loss was 15% (n=3) and Severe hearing loss was 30% (n=6).

Table 3: BERA Results

BERA	Normal AABR GROUP (n=141)	Abnormal AABR GROUP (n= 20)	Total (n=161)
Normal	140 (99.2)	5 (25.0)	145 (90.06)
Mild HL	0 (0)	6 (30)	6 (3.7)
Moderate HL	1 (0.7)	3 (15)	4 (2.48)
Severe HL	0 (0)	6 (30)	6 (3.72)

Sensitivity and Specificity of screening AABR when compared to BERA as gold standard is 93.7% and 96.5% respectively. The Positive predictive value and the Negative predictive value of screening AABR is 75% and 98.5% respectively.

Table 4: Diagnostic parameters of Screening AABR

		BERA		
		Abnormal	Normal	Total
AABR	Abnormal	15	5	20
	Normal	1	140	141
	Total	16	145	161

		95 % CI (%)	
	%	Lower	Upper
Sensitivity	93.70%	69.7	99.8
Specificity	96.50%	92.1	98.8
PPV	75%	55.6	87.7
NPV	99.20%	95.4	99.8

DISCUSSION

Hearing loss being an invisible disability, early detection of deafness has been a long-standing priority in the field of otology. Currently the mean age of identification of pediatric deafness is 24 to 30 months. This results in loss of precious duration of Cerebral plasticity. In India, hearing disability has a higher prevalence in children aged 0–4 years (0.60%) and 5–9 years (0.28%) than all other disabilities (0.32%).[8]

Neonates having bilateral hearing loss or unilateral hearing loss of varying degrees above 1000 Hz develop significant longterm effects on speech and language sciences.[9] Reduced auditory input also adversely affects growth of the auditory nervous system, and can negatively affect the speech perception that interferes with the increment in social, emotional, behavioral, and cognitive spheres, academic achievement, vocational alternatives, employment, and economic self-sufficiency.[10]

Every baby included in the study was screened with AABR and out of these 559 babies (abnormal AABR-23 : normal AABR-536) only for 161 babies (abnormal BERA-16 : normal BERA-145) has done follow-up BERA in our study. The Prevalence of hearing loss in screening (Abnormal AABR) in the study population (n=559) was 4.11%, Similar findings were noted by Mohammad et al,[11] (4.8 %), Shahin et al,[12] (4.2 %) & Gurudutt et al,[13] (3.6 %). According to Ana Carolina et al,[14] hearing loss prevalence was reported to be 8.3%, that is more than our study. The reason for this difference might include different screening protocols and real difference in hearing loss incidence in world.

The Prevalence of hearing loss (Abnormal AABR) in LBW babies (n=422) in the study population is 4.00%. Lower prevalence of Abnormal AABR in LBW babies was noted by Ana Carolina et al.,14 (2.20%) while higher prevalence noted by Prasad Kumar et al,[15] (6 %) & Shahin et al,[12] (14.8 %).

The Prevalence of hearing loss (Abnormal AABR) in Preterm babies (n=435) in the study population is 3.6%. Lower Prevalence of Abnormal AABR in babies <32wks was noted in present study as compared to by Prasad Kumar et al,[15] (6.9 %) & Shahin et al,[12] (9.4 %).

The Auditory Brainstem Response is the representation of electrical activity generated by the eighth cranial nerve and brainstem min response to auditory stimulation (recording of the synchronized response of numerous neurons in the auditory pathways within the brainstem).[16]

The Prevalence of Abnormal BERA in 9.9 % (n=16). This is much higher than that seen in screening AABR may be because BERA is done in small number of study population (n=160) and moreover BERA is done in almost all babies who failed in screening AABR and so that there is higher probability of getting abnormal BERA in babies with abnormal AABR. This is comparable with Gurudutt et al,[13] which showed 27.7%. The

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Prevalence of Abnormal BERA in LBW babies (n=139) in the study population is 8.6 %. The Prevalence of Abnormal BERA in babies <1.5 kg (n=73) and babies between 1.5kg and 2.5 kg (n=66) is 9.5 % and 7.5 %. This shows the risk of hearing loss is more in VLBW babies when compared to LBW babies.

Out of 16 babies with abnormal BERA, 6 babies (37.5 %) showed mild hearing loss, 4 babies (25 %) showed moderate hearing loss and 6 babies (37.5 %) showed severe hearing loss. This is comparable with Ann Mary et al,[17] (Mild Hearing loss - 48.7 %, Moderate Hearing loss - 17.9 % & Severe Hearing loss - 33.3 %) and Mohammed et al,[11] (Mild Hearing loss - 60 %, Moderate Hearing loss - 26.6 % & Severe Hearing loss - 13.3 %) which showed almost similar results.

Among the elements that determine the efficiency and appropriateness of a screening program are its sensitivity and specificity. Generally speaking, the higher the sensitivity of a tool the lower the false-negative cases and subsequently the lower side-effects and socioeconomic burden of the disease.[18] Furthermore, the higher the specificity of a tool the lower the referral of false-positive cases, and thus, the lower is its financial burden and resultant stress. If a hearing screening tool can detect a hearing disorder in a large population affected with similar disorders then that tool is said to have high sensitivity. If the same tool is used among a vast population of healthy individuals and the healthy ones are correctly detected then that tool is said to have high specificity.[18]

The sensitivity of screening AABR in our study is 93.7 % which shows it can detect 93.7 % of patients with the disease (true positives) and 6.3 % with the disease go undetected (false negatives). The specificity of screening AABR in our study is 96.5 % which shows it can correctly report 96.5 % of patients without the disease as test negative (true negatives) and 3.5 % patients without the disease are incorrectly identified as test positive (false positives). This is comparable with studies by Sena et al,[19] (Sensitivity 100 %, Specificity 100 %), Kuki et al,[20] (Sensitivity 94 %, Specificity 61 %), Jacobsan et al,[21] (Sensitivity 89 %, Specificity 96 %), Melagrana et al,[22] (Sensitivity 100 %, Specificity 97 %) & Hermann et al,[23] (Sensitivity 100 %, Specificity 98 %). The PPV and NPV of screening AABR in our study are 73.5 % and 99.2 % respectively which is comparable with Melagrana et al,[22] which showed 88.2% and 100% respectively.

Studies also indicate prevalence of hearing impairment among high-risk neonates is much higher than normal neonates. Referring neonates at high risk, such as those with a family history of deafness or those born with low birth weight, birth asphyxia, jaundice, or meningitis, for early assessment of hearing to ensure prompt diagnosis and appropriate management is necessary.[24]

CONCLUSION

Neonates with risk factors such as hyperbilirubinemia (SBR>20mg/dl), who underwent exchange transfusion, exposure to ototoxic drugs, ventilation >5 days, birth asphyxia and meningitis have shown greater risk of hearing loss. AABR is good screening test for hearing loss in high-risk newborns. The Sensitivity and Specificity of screening AABR are 93.7 % and 96.5 % respectively, against BERA as gold standard. The Positive predictive value and Negative predictive value of screening AABR are 75 % and 99.2 % respectively.

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