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Study of Hearing Loss in High Risk Infants using Brainstem Evoked Response Audiometry (BERA)

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Abstract:

1. *Introduction: Speech is the primary mode of human communication, but its acquisition appears to rely upon auditory experiences during a critical period between the age of birth to 3yrs. Screening is one of the most important methods of early diagnosis hearing loss. Brain stem response audiometry is the method of choice for accurate detection of hearing threshold. The present study emphasizes the importance of using ABR as a screening tool for the detection of hearing impairment at an early stage which would have otherwise got unnoticed till about 2-3yrs.*
2. *Material and Method: The study was conducted on thirty normal and thirty high risk infants referred to the department of ENT, Rajendra Institute of Medical Sciences, Ranchi.*

Study Design: Comparative study

After a detail history and clinical examination recording was done with AMPLAID MK 22 machines in a sound proof room. Sedation was used only when required. The hearing loss was quantified as mild, moderate and severe. An abnormal BERA necessitates a repeat test after three months.

3. *Results: Study Group consisted of thirty infants. There were 8 infants with birth asphyxia, 10 infants with hyperbilirubinemia, 1 with cytomegalovirus infection, 5 infants with low birth weight, 2 infants with craniofacial anomalies, 4 infants with family history of hearing loss. The incidence of hearing loss in high risk group was 70%. P value <0.5 which is significant. The incidence of hearing loss on doing a repeat test was 60% which is clinically significant. Of the abnormal BERA readings four patients had bilateral mild hearing loss. Moderate hearing loss was found in five infants. This was bilateral in four cases and unilateral in one case. Eight infants had profound hearing loss. Here there were seven infants with bilateral hearing loss and one infant with unilateral hearing loss. One infants had maturational delay which was bilateral.*

Control Group: *All the infants in the control group showed normal BERA readings.*

4. *Conclusion: The present study emphasizes the importance of using ABR as a screening tool for the detection of hearing impairment at an early stage which would have otherwise got unnoticed till about 2-3yrs. ABR audiometry because of its accuracy has emerged as a technique of choice in the screening infants as it is an objective test. There is also a need for large scale study on obtaining normal values and standardizing the procedures for effective applications.*

Key Words – *Infant; Brainstem Evoked Response Audiometry; High risk factors; Joint Committee on Infant Hearing.*

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I. Introduction

Speech is civilization itself. The word, even the most contradictory word, preserves contact. It is silence that isolates.—Thomas Mann

Hearing is a crucial link in the development of normal speech and language. The human ear has evolved in such a way as to be tuned with sensitivity to the range of human speech (Northern and Downs, 1991). Speech is the primary mode of human communication, but its acquisition appears to rely upon auditory experiences during a critical period between the age of birth to 3years. With deprivation of such auditory experiences, a child's speech and language development will never fully attain its potential (Northern and Downs, 1991). Additionally, delays in speech and language development can cause delays in other aspects of child development, such as literacy, overall academic achievement, social and emotional development (Hayes and Northern, 1996). Hearing loss during childhood, therefore, can have far-reaching effects on a child's development.[1]

Speech and language development may begin as early as in the womb and in fact, the infant is born with necessary neural substrate to develop speech and language. However, the environmental stimulation is of paramount importance to strengthen the synaptic connections. If there is no stimulation, as in the case of deafness, the synapses die out. Hence, for synaptic maturation, the speech must be audible. Audition is vital in the process of normal speech and language development. A deaf infant who ages without the ability to hear speech has fewer and fewer synapses available to develop auditory perceptions and language skills (Chugani, 1997).[2]

These effects on development can be reduced with intervention. However, due to the brief and early critical period for language hearing, this intervention must occur as early in the hearing impaired child's life as possible. The invisibility of hearing impairment partly of the reason that the average age for identification of hearing loss is thought to currently be between two and three years of age, nearly the end of the critical period for speech and language learning. It is necessary to establish a way in which children with hearing loss can be identified at a much earlier age. This has come in the form of hearing screening programmes.[1]

The Joint Committee on Infant Hearing (JCIH) endorses early detection of and intervention for infants with hearing loss. The goal of early hearing detection and intervention (EHDI) is to maximize linguistic competence and literacy development for children who are deaf or hard of hearing. Hearing of all infants should be screened at no later than 1month of age. Those who do not pass screening should have a comprehensive audiological evaluation at no later than 3months of age. Infants with confirmed hearing loss should receive appropriate intervention at no later than 6months of age from health care and educational professionals with expertise in hearing loss and deafness in infants and young children.[3]

The importance of early rehabilitation of early and prelingual childhood hearing loss is undisputed. The worldwide incidence of severe hearing loss in newborns esteems 2:1000 of live births. Including mild cases of hearing impairment, incidence is as high as 5:1000. Hearing loss in mild and moderate forms, may not be recognized before the second year, but may produce great defects in conversational abilities.[4] 1-4 Newborns with predisposing risk factors have a tenfold probability to develop hearing-loss.

The incidence of hearing disability is 2-3 per 1000 live births in India and 1 per 1000 babies is profoundly deaf at birth or in the prelingual childhood period. Approximately 50% of the cases are thought to be due to genetic factors, upto 40% due to environmental factors and the remaining are due to unknown causes.[5]

According to the calculation of the WHO worldwide approximately 350 million people have hearing disorders. The overall prevalence of congenital hearing disorders is 1-3 in 1000 newborns, the prevalence in high risk groups is estimated at about 10times higher.[6]

According to the International Deaf Children's Society, there are an estimated 3 million deaf children in India. Four in every 1,000 children are born deaf, with 25,000 deaf babies are born every year. Only one in 10 deaf children goes to school and 50% of them drop out at the age of 13.[7]

It is not possible to assess neonates hearing threshold accurately by behavioral techniques.

The availability of cochlear implants as radical effective treatment for sensorineural deafness opens up the need for early detection and hence detection of screening of high risk infants.

Objectives are:

1. To detect the incidence of hearing loss in normal and high risk infants using BERA.
2. To quantify the hearing loss in normal and high risk infants using BERA.

II. Materials And Methodology

The study was conducted on thirty normal and thirty high risk infants referred to the department of ENT Rajendra Institute of Medical Sciences, Ranchi.

Study group: Thirty high risk cases referred to the department of ENT were evaluated for hearing loss by Brainstem Evoked Response Audiometry (BERA).

Control group: Thirty normal sex and age matched cases were evaluated for hearing loss by BERA.

Procedure: The following information about the infant was recorded: gestational age, sex, birth weight, admitting diagnosis, period of hospitalisation and possible risk factors. A clinical examination was done. Sedation was used only when required. Recording was done with AMPLAID MK 22 machine in a sound proof room. After securing the various electrodes a click stimulus starting at 100dB at the rate of 31 clicks per second is presented to each ear individually. The recordings were plotted as Jewett waves I to VI of which the Ist and Vth wave are of greatest significance. The hearing loss was quantified as mild, moderate and severe. An abnormal BERA necessitates a repeat test after three months. Quantification of the hearing was based on the Scale of hearing impairment by Clark (1980).

AVERAGE THRESHOLD LEVEL(dB).	Suggested Descripion
10-15	Normal hearing
16-25	Slight hearing loss
26-40	Mild hearing loss

41-55	Moderately severe hearing loss
56-70	Severe hearing loss
71-90	Profound hearing loss

Analysis: Data was analysed by Chi-square, Fisher's test, t- test.
Inclusion criteria: Infants with atleast one of the following high risk factor will be taken into the study.
High risk criteria
Parental or caregiver concern regarding hearing, speech, language, and/or developmental delay
• Family history of congenital or delayed onset childhood sensorineural hearing loss
• Maternal infections-toxoplasmosis, syphilis, rubella, cytomegalovirus, herpes
• Craniofacial abnormalities
• Birth weight <1500g
• Hyperbilirubinaemia at a level exceeding indication for exchange transfusion
• Ototoxic drugs (aminoglycosides) (Infant and mother)
• Bacterial meningitis
• Severe respiratory depression at birth
• Stigmata or other findings associated with a syndrome known to include sensorineural hearing loss (e.g. Waardenburgs or Ushers syndromes)
Exclusion criteria: High risk infants whose parents do not consent to BERA. Infants on ventilator who are severely ill.

III. Results

Study Group
This group consisted of thirty infants. There were 8 infants with birth asphyxia, 10 infants with hyperbilirubinimia,1 with cytomegalovirus infection, 5 infants with low birth weight, 2 infants with craniofacial anamolies,4 infants with family history of hearing loss.

Table 1: Incidence of Hearing Loss among High Risk Babies and Normal Infants

	Affected	Not Affected	Total
Study	21 (70%)	9 (30%)	30
Control	0	30 (100%)	30
Total	21	39	60

The incidence of hearing loss in high risk group was 70%. P value <0.5 which is significant.

Table 2: Hearing Level among various risk factors in Males (Left Ear)

Risk factor	Mild	Moderate	Profound	Maturational delay	Normal	Total
Birth asphyxia			1	1	2	4
Hyperbilirubinemia	1		2		1	4
Low birth weight					2	2
CMV						
Family history of Hearing loss		1			2	3
Craniofacial anomalies		1				1

Table 3: Hearing Level among various risk factors in Males (Right Ear)

Risk factor	Mild	Moderate	Profound	Maturational delay	Normal	Total
Birth asphyxia	1		1	1	1	4
Hyperbilirubinemia	1		2			3
Low birth weight					2	2
CMV						
Family history of Hearing loss			1		2	3
Craniofacial anomalies		1				1

Table 4: Hearing Level among various risk factors in Females (Left Ear)

Risk factor	Mild	Moderate	Profound	Maturational delay	Normal	Total
Birth asphyxia		3			1	4
Hyperbilirubinemia	1		2		3	6
Low birth weight					3	3
CMV	1					1

Family history of Hearing loss					1	1
Craniofacial anomalies					1	1

Table 3: Hearing Level among various risk factors in Females (Right Ear)

Risk factor	Mild	Moderate	Profound	Maturational delay	Normal	Total
Birth asphyxia		3	1			4
Hyperbilirubinemia	1		2		3	6
Low birth weight					3	3
CMV	1					1
Family history of Hearing loss					1	1
Craniofacial anomalies			1			1

Control Group: All the infants in the control group showed normal BERA readings.

IV. Discussion

The study group had 14 males and 16 females in each group which were age and sex matched. In the control group there was no significant variation in the BERA peaks and latencies. This was consistent with the findings of Durieux et al .

There were 21 infants who were affected in the study group out of the total 30 infants whereas all the infants in the control group had normal hearing. The incidence could not be calculated as all the infants were normal in the control group. Therefore an analysis was done by Fischer's p which showed>0.5 which is highly significant. This means that a significant number of cases were affected with hearing loss in the high risk group using BERA. As per available literature the overall prevalence of congenital hearing disorders is 1-3 in 1000newborns, the prevalence in high risk groups is estimated at about 10 times higher.

The various risk factors were birth asphyxia, hyperbilirubinemia, low birth weight, craniofacial anomalies, maternal infection, family h/o hearing loss. For ease in tabulation separate tables were made for left and right ear.

The various hearing losses identified in this study were

1. Profound hearing loss-no identifiable peaks at or below 90dB
2. Moderate hearing loss- no identifiable peaks at or below 45 dB
3. Mild hearing loss- no identifiable peaks at or below 35dB
4. Maturational delay of the BERA peaks- there were peaks at various levels but there was a delay in the conduction of the sound impulses

V. Conclusion

The present study emphasizes the importance of using ABR as a screening tool for the detection of hearing impairment at an early stage which would have otherwise got unnoticed till about 2-3yrs.This would further help us in early rehabilitation of the child as this would make the child socially acceptable.

ABR audiometry because of its accuracy has emerged as a technique of choice in the screening infants.

Since it is an objective test it useful in early identification of hearing loss. According to the EDHI all infants should be screened for hearing loss. In developing countries like India screening all infants with BERA would be a herculean task due to the cost involved.

Screening the high risk infants would detect most of the hearing impaired infants.

There is also a need for large scale study on obtaining normal values and standardizing the procedures for effective applications.

Parents play a large role in helping their infants overcome to this disability.

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