

## Original Research Article

# Objective screening of hearing impairment using brainstem evoked response audiometry in children below 5 years of age and assessing the high risk factors

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### ABSTRACT

**Background:** Hearing impairment is a common disability in children. This study is to evaluate the common high risk factors for hearing loss in our locality and to estimate hearing threshold by brain stem evoked response audiometry.

**Methods:** 100 children under five years were subjected to brainstem evoked response audiometry. Wave V morphology was studied and hearing threshold estimated. The high risk factor(s) were analysed and degree of hearing impairment assessed.

**Results:** 38 children were found to have hearing impairment. Most of the children had bilateral hearing impairment. Of them 30 children (79%) had profound hearing loss. Consanguineous marriage was the most common risk factor.

**Conclusions:** Since consanguinity is the most common risk factor, health education and genetic counselling will help to decrease the incidence of autosomal recessive nonsyndromic deafness. Improvement in immunization for rubella can decrease the hearing impairment due to these infections. Due to availability of medical facilities hearing impairment due to perinatal factors have decreased.

**Keywords:** Brainstem evoked response audiometry, Newborn hearing screening, Objective screening of hearing, Consanguinity

### INTRODUCTION

Childhood hearing loss affects 0.5 to 6 per 1000 newborns.<sup>1</sup> First 36 months after birth is critical period in cognitive and linguistic development and it depends on normal hearing capacity. Early identification of defective hearing and appropriate intervention can reduce disability significantly and improve linguistic skills in the hearing impaired children. Various audiological tests are used to assess hearing sensitivity in children, but only objective hearing tests provide an accurate assessment of hearing loss. Brainstem evoked response audiometry (BERA) is a non invasive objective test for early identification of

hearing impairment in neonates, infants and children. BERA testing measures the stimulus evoked electrophysiological response of the eighth cranial nerve and brain stem to clicks or tone bursts presented to external ear. The response is recorded from the electrodes on the skin. Wave V detection thresholds correlate best with hearing sensitivity. In this study BERA test was done on high risk neonates and children below 5 years of age for threshold estimation. There is not enough literature on this topic from this region and there is need to find commonly prevalent potential high risk factors in the region.

## METHODS

The study was conducted on 100 children below 5 years of age, in outpatient department of ENT, tertiary care hospital in North Karnataka from November 2017 to March 2018 after obtaining approval from the Institutional Ethics Committee. Neonates with high risk factors, infants who were clinically suspected of hearing loss and children with delayed speech development were all consecutively included in the study. Developmental milestones including speech and language were noted. History regarding high risk factors like consanguinity, family history of childhood deafness, maternal infections (TORCHES), perinatal asphyxia, delayed cry, low birth weight, prematurity, NICU admission and neonatal jaundice was taken. Thorough clinical examination was done. The parents were counseled regarding BERA test, possibility of child having hearing loss and the need for early diagnosis and intervention, informed consent was obtained. Syrup pedichloryl was given in appropriate dose half an hour before to sedate the baby. RMS BERA instrument was used. Surface electrodes were applied over vertex, forehead and both mastoids. Headphones were applied. The test was done in a sound proof room. The morphology of the graph was noted until wave V is no longer identifiable. The minimum intensity at which wave V is identifiable is taken as hearing threshold for that individual. The hearing impairment is considered mild for 30-45dB hearing loss, moderate for 50-65dB loss, severe for 70-85dB loss and profound hearing impairment for loss of 90dB and above.<sup>2</sup> The data entry was done in Microsoft excel. The data was tabulated and analyzed by using percentage and proportions.

## RESULTS

Among the 100 study participants 28 were infants and 32 were 1 to 3 years old and 40 were in age group of 3 to 5 years. Among these 52 were females and 48 were males.

**Table 1: Distribution of hearing loss in the study subjects.**

Severity of hearing loss	Male	Female	Total (n=38) (%)
<b>Mild</b>	0	0	0
<b>Moderate</b>	3	5	8 (21)
<b>Profound</b>	15	15	30 (79)
<b>Total</b>	18	20	38

Of these 38 were found to have hearing loss. Among these 18 were males and 20 were females. Of these 8 children (21%) had moderate hearing loss and 30 children (79%) were found to have profound hearing loss. Only one child had unilateral hearing loss and all other children had bilateral hearing loss.

Among the high risk factors consanguineous marriage was the most common risk factor. It was noted in 22 children (57.8%). Other risk factors were birth asphyxia, low birth weight and hyperbilirubinemia. The study

included two babies with congenital rubella infection and one baby with family history of childhood deafness. This indicates that presence of risk factor significantly affects the auditory system and causes hearing impairment. 10 patients had multiple risk factors.

**Table 2: High risk factors observed in study participants.**

S.No.	Risk factors	Number of participants with the risk factor (n=38) (%)
<b>1</b>	Consanguinity	22 (57.8)
<b>2</b>	Birth asphyxia	3 (7.9)
<b>3</b>	Low birth weight	6 (15.7)
<b>4</b>	Hyperbilirubinemia	4 (10.5)
<b>5</b>	Family history of childhood deafness	1 (2.6)
<b>6</b>	Congenital rubella	2 (5.2)

## DISCUSSION

Hearing loss early in development can be highly detrimental to the linguistic and cognitive development of an affected child. Early intervention in hearing challenged child will reduce such developmental losses. So it is important to screen every child's hearing beginning at birth so that early detection can be made and intervention started early.

Severe deafness in children is due to sensorineural hearing loss (SNHL). Screening is conducted by using objective tests like Otoacoustic emission (OAE) testing and BERA. OAE are sounds of cochlear origin, which can be recorded by a microphone fitted into the ear canal. They are caused by the motion of the cochlear hair cells as they energetically respond to auditory stimulation. OAEs provide simple non-invasive indicator of cochlear function.<sup>3</sup> BERA measures the electroencephalographic wave form response from the vestibulocochlear nerve and brainstem.

In our study, consanguineous marriage was found to be the commonest associated risk factor (57.8%). The prevalence of consanguinity is high in India.<sup>4</sup> The most common union is the marriage between first cousins. These couples tend to come from lower educational and socioeconomic groups, they are traditionally religious and tend to get married early.<sup>5</sup> Offsprings of such marriages inherit identical complementary strands of DNA through a parentally shared common ancestor. Awareness to discourage consanguineous marriage, health education efforts might help to decrease the incidence of autosomal recessive non-syndromic sensorineural hearing loss (SNHL). In a study by Ramanathan et al consanguinity was the most common risk factor.<sup>1</sup>

Two participants had proven history of congenital rubella infection. Infections of mother in pregnancy that can damage fetus are traditionally grouped as TORCH infections (toxoplasmosis, others, rubella, cytomegalovirus and herpes simplex virus). They not only cause SNHL but also visual loss and behavioural and neurological dysfunction. Globally the incidence of congenital rubella has been greatly decreased by the introduction of rubella vaccine. But in countries like India congenital rubella is important cause of acquired congenital SNHL.<sup>6</sup> Rubella vaccine has recently been introduced in National immunization schedule in India, hence rubella induced hearing impairment can be expected to decrease in future.

Other causes of acquired SNHL in infants and children are bacterial meningitis. Post-meningitic SNHL can be unilateral or bilateral, but bilateral loss is slightly more common. The WHO global program for vaccines and immunization has provided recommendations for the prevention of congenital rubella syndrome and studies also support the inclusion of vaccines against *Haemophilus influenzae* and *Streptococcus pneumoniae*.<sup>7</sup> The bacterial meningitis can lead to hearing loss in a child of any age and all children diagnosed should be screened.<sup>8</sup> Measles infection can cause severe to profound bilateral hearing loss and mumps infection causes mostly unilateral hearing loss.<sup>9</sup> Triple MMR vaccine can protect against measles, mumps and rubella.

In this study 6 children had low birth weight and preterm. Preterm and low birth weight (LBW) infants are particularly susceptible to factors such as hypoxia and hyperbilirubinemia. Babies admitted to neonatal intensive care unit for >48 hours were 10 times more likely to have a permanent hearing loss than those who did not undergo intensive care. Hypoxia is associated with apnoea, difficult delivery, low APGAR scores and use of ventilation. It is associated with neurodevelopmental deficits and hearing loss.<sup>10</sup> NICU admission is usually associated with administration of ototoxic drugs. Delayed cry, birth asphyxia, cerebral palsy and neonatal seizures can cause brain hypoxia affecting central auditory pathways leading to hearing loss.

Hyperbilirubinemia is independent risk factor.<sup>11</sup> In neonatal jaundice, bilirubin toxicity can cause sensorineural hearing loss. This is usually transient and improves with phototherapy. Persistent hearing loss in some cases is due to axonal degeneration and loss of myelin. The syndromes associated with hearing loss are Pendred's syndrome, Usher's syndrome, Waardenberg syndrome.

This indicates that presence of risk factor significantly affects the auditory system and causes hearing impairment. And the presence of risk factor does not lead to hearing impairment in all the cases. Hearing impairment can occur in the absence of risk factor. Hence there is a need for universal hearing screening program.

## CONCLUSION

Consanguineous marriage is the most common high risk factor in our study. This emphasizes the need for health education and genetic counselling. Immunization for the measles, mumps and rubella administered as MMR vaccine can help in control of hearing impairment due to these viral infections. Immunisation coverage for *Haemophilus influenzae* and pneumococci needs to be improved. They constitute vaccine preventable deafness. Routine screening of pregnant women is needed for detection of TORCH infection. Due to availability of medical facilities hearing impairment due to perinatal risk factors has decreased. Hearing loss is a common disability and is difficult to detect clinically in newborn. The screening tests like BERA are required for early diagnosis of deafness. BERA test gives accurate picture of hearing sensitivity. Early detection leads to early implementation of rehabilitation process. Not all babies with high risk factors have hearing impairment. So all newborn babies should be screened for hearing loss ideally, because of lack of availability of services high risk screening is done. Deafness can be acquired at any time in childhood, so regular screening and follow-up is required.

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