Original Research Article

Audiological screening of high risk infants and prevalence of risk factors

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ABSTRACT

Background: Hearing loss in early life can have deleterious effects on child's psychosocial, scholastic and social-emotional development. Early identification and timely intervention can provide the child with better speech and language development. This study has been done to estimate the prevalence of hearing impairment among high risk infants as per Joint Committee on Infant Hearing (JCIH) criteria and to study the risk factors associated with neonatal hearing impairment.

Methods: This multicentric observational study was conducted among 613 high risk infants admitted and discharged from neonatal intensive care units (NICU) of Academy of Medical Sciences, Kannur, Kerala and Sri Siddhartha Medical College and Research Centre, Tumakuru, Karnataka, India (level III neonatology units with an NICU admissions of average around 1200 per year), during the period August 2015 - August 2016 (12 months). The babies were selected based on the JCIH 2007 criteria. All babies were subjected to behavioral audiometry (BA) and Oto Acoustic Emissions (OAE), preferably within 3 weeks. Those failing OAE were reevaluated at 6th week and with Auditory brain stem response (ABR) within 3 months time.

Results: A total of 613 high risk babies were screened. 42 (6.76%) among them were having hearing impairment. The most common risk factors associated with hearing impairment was NICU stay for more than 24 hours, prematurity, low birth weight and meningitis/sepsis etc.

Conclusions: Hearing impairment among high risk babies is not a rare condition. In our study, the prevalence was 6.76%. Low birth weight, admission to NICU for more than 24 hours, low APGAR, meningitis/sepsis, maternal and neonatal complications are significant risk factors for hearing impairment among neonates. This highlights the need for neonatal screening. Though we recommend a universal screening program, at least a targeted approach should be practiced in neonatal care. Those babies who are found to have hearing impairment should be closely followed up with early intervention and rehabilitation.

Keywords: Hearing impairment, Neonatal screening, New born screening, OAE, Risk infants, Universal screening

INTRODUCTION

Hearing loss in very early life has shown multiple deleterious effects on the child related to attainment of speech and language. Early screening and recognition of hearing impairment is the fundamental step to reduce the

negative consequences on a child's psychosocial, scholastic and social-emotional development. If recognized and intervened before 6 months, this can result in significantly better language development in the child.^{1,2} Congenital deafness/hearing impairment may be present in neonates at risk or not at risk. Various studies

have reported a prevalence of hearing impairment ranging from 0.09 to 2.3% in normal neonates and 0.3 to 20.68% in high risk infants.¹⁻³

In 1999, the American Academy of Pediatrics (AAP) advocated Universal screening of newborn hearing before 3 months and remedial measures, to maximize linguistic and communicative competence and literacy development for hearing impaired children.⁴ The Joint Committee on Infant Hearing (JCIH) has also proposed necessary guidelines and the risk indicators, which can be locally adapted to identify infants at risk.⁵

Routine new born screening has been implemented in many developed countries with varying success rates.⁶⁻¹⁰ Many of these countries follows the AAP guidelines. But in many developing countries including India, universal screening is not available and follows elective screening in high risk infants.^{11,12} Various Indian studies have reported that four per thousand neonates have severe to profound hearing loss.^{13,14} This observational study was conducted to study the prevalence of hearing impairment in high risk infants, to study the neonatal risk factors and their association with hearing impairment.

METHODS

This multicentric study consists of 613 high risk infants admitted and discharged from neonatal intensive care units (NICU) of Academy of Medical Sciences, Kannur, Kerala and Sri Siddhartha Medical College and Research Centre, Tumakuru, Karnataka, India (level III neonatology units with an NICU admissions of average around 1200 per year), during the period August 2015 – August 2016 (12 months). The study was approved by the Institutional Review Board and ethical clearance was obtained for the study from the hospital ethics committee. Parental consent was obtained at the time of enrolment.

After obtaining the consent from the parents, a detailed clinical examination of the babies was done. Complete prenatal, natal and post-natal history was taken. All new born babies were then subjected to behavioral audiometry (BA) and oto acoustic emissions (OAE), preferably within 3 weeks. The result of OAE was interpreted as “pass” or “refer”. All those babies who were in “refer” group were re-evaluated at 6th week. Those babies who still remaining “refer” were further evaluated with Auditory brain stem response (ABR) within 3 months’ time. The babies who were proven to have hearing loss were referred to an ear, nose and throat specialist for further evaluation and rehabilitation.

Inclusion criteria

High risk groups

Infants with anyone of the following high risk factors

- Family history of deafness

- Maternal infection (TORCH)
- Preterm Infants
- Low Birth Weight (LBW) <1500g at birth
- Low APGAR scores
- Birth asphyxia
- Congenital anomalies
- Hyperbilirubinemia requiring exchange transfusion
- Babies with any comorbidities (Sepsis, Necrotizing Enterocolitis, Convulsions, Hypothyroidism, Hypoglycemia, Hypocalcemia, Intraventricular hemorrhages, Meconium staining, Meconium aspiration)
- NICU admission more than 5 days
- Ototoxic drug administration

Exclusion criteria

- Parent’s not giving consent for OAE/ABR

RESULTS

A total of 613 babies were included in the study. Among them 56.93% (n = 349) were male and 43.06% (n = 264) were female babies.

Table 1: Risk factors among study population.

	Males	Females	Total
NICU Stay > 24 hours	113	98	211
Prematurity	66	72	138
Low birth weight	59	38	97
Neonatal co-morbidity	26	31	57
Meningitis / sepsis	12	14	26
Low APGAR	29	14	43
Maternal risk factors	27	16	43
Birth asphyxia	22	17	39
Congenital anomalies	15	6	21
Family history	9	4	13
Ototoxic drugs	27	18	45
Hyperbilirubinemia	22	12	34

Table 2: Incidence of hearing impairment in high risk infants.

	M	F	Total	% (n = 613)
NICU stay > 24 hours	17	9	26	4.24%
Prematurity	7	5	12	1.95%
Low birth weight	7	4	11	1.79%
Neonatal co-morbidity	5	3	8	1.30%
Meningitis / sepsis	4	2	6	0.97%
Low APGAR	2	2	4	0.65%
Maternal risk factors	1	3	4	0.65%
Birth asphyxia	0	1	1	0.16%
Congenital anomalies	1	0	1	0.16%
Family history	1	0	1	0.16%
Ototoxic drugs	0	1	1	0.16%
Hyperbilirubinemia	0	0	0	0

DISCUSSION

Hearing impairment in children is a hidden disability. By the time, it is recognized usually at 2-3 years, the child's speech and language ability will be irreversibly affected. Early detection of hearing impairment and timely intervention can give better consequences.

Various other studies have reported an incidence of hearing impairment ranging from 0.3 to 20.68% in high risk infant.¹⁻³ In our study, we found a prevalence 6.76% (n = 42) of hearing impairment among high risk infants. Our findings were similar to John et al (6.4%) and Gouri et al (5.30%).^{15,16} But it contradicts Nagapoomima et al findings.¹⁷ She did a similar study of screening for 279 high risk south Indian babies and reported a 1% prevalence rate of hearing impairment. The higher incidence in our study may be due to different risk factors, unseen environmental and genetic factors etc.

In our study, we found a higher incidence of hearing impairment among male babies, than in female babies. Maqbool et al in their study reported that gender doesn't affect hearing outcome.¹⁸

68.42% (n = 26) of hearing impaired babies had NICU stay for more than 24 hours. JCIH 2007 guidelines conclude that, any illness or condition requiring admission of 24 hours or more to NICU is a risk factor for hearing impairment.⁵

31.57% (n = 12) of hearing impaired babies in our study were premature (Gestational age $\leq$ 36 weeks). The prevalence for prematurity was higher than Vasishta et al (17.02%).⁴ Beswick et al in a systematic review concluded prematurity as a risk factor for hearing impairment. Vasishta et al also drew the same conclusion.¹²

In our study 28.94% (n = 11) of hearing impaired babies were low birth weight (<1500gm at birth). JCIH 2007 criteria, John et al, Gouri et al, Beswick et al and Sun et al concluded that low birth weight is a significant risk factor for hearing impairment.^{5,15,16,19,20}

8 out of our 42 (19.04%) hearing impaired babies were having one or more associated comorbid conditions like neonatal seizures, hypoglycemia, hypocalcemia, meconium stained liquor, meconium aspiration, intraventricular hemorrhage, necrotizing enterocolitis, congenital diaphragmatic hernia etc. Hearing impairment in these babies could be due to fetal hypoxia caused by these comorbid conditions which can lead to damage to cochlear cells and neuronal pathways.^{16,20,21}

In our study, 15.78% (n = 6) of hearing impaired babies were having meningitis / culture positive sepsis. AL-Harbi M et al, KY Chan et al and Meyer A et al concluded that bacterial meningitis is significant factor associated with failed ABR in new born screening,

probably due to vasculitis of inner ear or adhesions comprising eighth nerve.²²⁻²⁴

10.52% (n = 4) of hearing impaired babies were having an APGAR score of ≤ 5 at birth. Thomson et al, Gouri et al and Maqbool et al reported an incidence of hearing impairment of 1.2%, 16.7% and 12.5% respectively in low APGAR babies.^{16,18,25} All of them concluded that first minute APGAR score ≤ 5 is a significant risk factor for hearing impairment. JCIH also included low APGAR as a risk factor for hearing impairment in newborns.⁵

It was also noted that hearing impairment was significant for babies who are having maternal complications (like TORCH infections, premature rupture of membranes, pregnancy induced hypertension, gestational diabetes, prolonged labour, oligohydramnios, antepartum hemorrhage). JCIH, Beswick et al, Sun et al and various other studies have also concluded that monitoring of the hearing condition of the infants are warranted in cases of maternal complications.^{5,19,20}

Two babies with birth asphyxia failed in initial screening, but only one baby failed in second screening and ABR. The transient hearing loss in one baby may be due to the middle ear effusion associated with ventilated babies.¹⁸ Borg et al in a systemic review concluded that perinatal hypoxia causes transient hearing impairment and birth asphyxia is not correlated with hearing loss in babies with complicated deliveries.²⁶ Amini et al also concluded the same.²⁷

One baby in our study had craniofacial malformation along with hearing impairment. Beswick et al, Sun et al, and JCIH have marked craniofacial anomalies as a risk factor.^{5,19,20}

Though 9 babies in our study had a family history of pediatric hearing impairment, only one baby (2.63%) failed screening. John et al (1.4%), Gouri et al (3%) also reported a similar incidence.^{15,16} Driscoll et al in a large retrospective population cohort study (n = 3,80,895) concluded that children with a family history of hearing loss should be screened at birth in and followed up throughout the child hood.²⁰

In our study 27 babies were exposed to ototoxic drugs. But only one among them had hearing impairment. This baby had other risk factors (NICU stay, prematurity, low birth weight and hyperbilirubinemia) also. Christiane Meyer et al, A Zamani et al concluded that use of ototoxic drugs is a risk factor for hearing impairment in neonates.^{24,29}

Hyperbilirubinemia induced neurotoxicity can cause sensory neural hearing loss (SNHL) and auditory dyssynchrony or auditory neuropathy spectrum disorder (ANSND).³⁰ None of our babies had hearing loss due to hyperbilirubinemia. This may be due to timely intervention. Wickremasinghe et al concluded that only

bilirubin levels ≥ 10 mg/dL above AAP Exchange transfusion thresholds (ETT) were associated with SNHL. With total serum bilirubin levels 0 to 4.9 mg/dL above ETT, the excess risk for hearing loss is 0.5%.³⁰

In our study, we found that method of delivery doesn't have any significance on hearing impairment.

Eight of our hearing-impaired babies were having three or more risk factors and six babies were having two risk factors together.

The main limitation of our study was a small sample size and we could not evaluate all risk factors of JCIH criteria. We recommend a large scale population based study with long term follow up to analyze the improvement in social and language development of hearing impaired children following appropriate intervention.

CONCLUSION

It was found a quiet high incidence of hearing impairment among at risk infants. Prematurity, low birth weight, admission to NICU for more than 24 hours, low APGAR, meningitis/sepsis, maternal and neonatal complications are significant risk factors for hearing impairment among neonates.

This emphasizes the importance of neonatal screening in such high-risk infants. Although we recommend a universal screening program, at least a targeted approach should be practiced in neonatal care and this will be more feasible in a limited resource setting. Neonatologists have a special role in this who can explain the impact of hearing impairment and the need for new-born screening to parents, thereby increasing the adherence to screening programs and further follow up.

These hearing-impaired children should be closely followed up with early intervention and rehabilitation to improve their speech and language development.

Best practices

- Universal screening programs and if possible implementation of a national program for neonatal hearing screening
- Better antenatal, perinatal care
- Early diagnosis and treatment in case of neonatal jaundice
- Avoidance of ototoxic drugs
- Immunization of women of child bearing age against rubella before pregnancy
- Educating gynecologists, pediatricians, neonatologists about the impact of hearing impairment, need for early diagnosis, intervention, treatment options available
- Awareness and teaching program for graduates, post graduates and nurses attending neonates.

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