International Journal of Research in Medical Sciences
Singh PK et al. Int J Res Med Sci. 2017 Apr;5(4):1554-1557
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20171264

Original Research Article

A prospective study for hearing screening of 4356 newborns by transient evoked oto-acoustic emissions and brainstem evoked response audiometry: a study of high risk factors for hearing loss

Pradeep Kumar Singh[1], Nishant Kumar[1]*, Dheeraj Kumar[1], Nisha Shrivastava[1], Abhishek Kumar[2]

[1]Department of ENT, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India
[2]Department of Public Service Management, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India

Received: 30 January 2017
Accepted: 07 March 2017

***Correspondence:**
Dr. Nishant Kumar,
E-mail: p.nishantk@gmail.com

ABSTRACT

Background: A child's normal speech and language development depends on the ability to hear. Early detection of hearing loss by screening at or shortly after birth and appropriate intervention are critical to speech, language and cognitive development. Objectives were to describe socio-epidemiological profile of newborns for hearing loss screening by transient evoked oto-acoustic emissions (TEOAE) and brainstem evoked response audiometry (BERA) in Rajendra Institute of Medical Sciences (RIMS), Ranchi, Jharkhand, India during 18 months period (June 2015-November 2016), and to study association between hearing loss and risk factors.
Methods: This prospective study was done on 4356 newborns for hearing screening by TEOAE in maternity ward and NICU and BERA in those noted "refer" on retest TEOAE at RIMS, Ranchi, Jharkhand, India during the period of 18 months (June 2015 - November 2016). Follow- up done by visits and phone calls. Templates were generated in MS excel sheet and data analysis was done using SPSS software (version 20).
Results: Study showed 3.90/1000 newborns were noted "refer" on retest TEOAE. Hearing loss (BERA- Fail) is slightly more common in males (2.20/1000 newborns), of rural areas (2.44/1000 newborns), tribal ethnicity (2.75/1000 newborns) and those delivered by lower section caesarean section (LSCS) (4.47/1000 newborns). Hearing loss noted in 2.07/1000 newborns. Among high risk newborns 21.41/1000 newborns were noted "refer" on retest TEOAE and 11.53 were found BERA fail.
Conclusions: Hearing loss was 21.71 times more common in newborns associated with high risk factors, mainly low birth weight and preterm newborns.

Keywords: BERA, Hearing loss, Newborn screening, Risk factors, TEOAE

INTRODUCTION

The prevalence of hearing loss is 0.5-6/1000 neonates all over the world.[1] Screening of the newborns and infants is the cost-effective way to reduce the burden of hearing loss. The objective of the current review was to see the status of the screening in neonates for the hearing impairment in India and suggesting ways of incorporating it in the national program. OAEs are believed to reflect the active biomechanical movement of the basilar membrane of the cochlea. The first level of hearing screening takes place during the first 2-3 days of life,

using the otoacoustics emission (OAE) test.[2] The 4 types of OAE are as follows:

- Spontaneous OAEs (SOAEs)- Sounds emitted without an acoustic stimulus (i.e, spontaneously).
- Transient OAEs (TOAEs) or transient evoked OAEs (TEOAEs)- Sounds emitted in response to an acoustic stimulus of very short duration; usually clicks but can be tone-bursts.
- Distortion product OAEs (DPOAEs)- Sounds emitted in response to 2 simultaneous tones of different frequencies.
- Sustained-frequency OAEs (SFOAEs)- Sounds emitted in response to a continuous tone.[3]

"Refer" or "did not pass" means that the child will either be screened a second time, or referred for a diagnostic audiological evaluation.

Brainstem evoked response audiometry (BERA) is a simple, non-invasive, objective test for early identification of hearing impairment in children and neonates. It can be used as a screening test in new-borns, infants and other difficult to test subjects. It detects electrical activity from the inner ear to the inferior colliculus. It gives an estimate of degree and type of hearing impairment, the cause of delayed speech and localize the site of lesion in patients with hearing loss.[4] In auditory brain stem evoked response audiometry, the impulses are generated by the brain stem. These impulses when recorded contains a series of peaks and troughs. BERA is resistant to the effects of sleep, sedation, sleep and anesthesia. The positive peaks (vortex positive) are referred to by the Roman numerals I - VII. These peaks are considered to originate from the following anatomical sites:

- Cochlear nerves- waves I and II.
- Cochlear nucleus- wave III.
- Superior olivary complex- wave IV.
- Nulclei of lateral lemniscus- wave V.
- Inferior colliculus- waves VI and VII.

These peaks occur in most readable form in response to click stimuli over a period of 1 - 10 milliseconds after the stimulus in normal hearing adults.

High risk factors:[5-7]

- Intrauterine infections (TORCH)- Cytomegalovirus (CMV), herpes, rubella, syphilis, and toxoplasmosis.
- Craniofacial anomalies, including those that involve the pinna, ear canal, ear tags, ear pits, and temporal bone anomalies.
- Hyperbilirubinemia requiring Exchange transfusion or kernicterus.
- APGAR scores of <4 in the 1st minute or <6 in the 5th minute.
- NICU stay >5 days.
- Low birth weight (LBW) <1.5kg.
- Gestational Age <32weeks.
- Manifestations of congenital anomalies or syndromes with hearing loss, such as Usher-refsum syndrome, fetal alcohol syndrome (FAS), Waardenburg syndrome, Alport syndrome, Pendred syndrome, and Jervell and Lange-Nielson syndrome.
- Neurodegenerative disorders, such as Hunter syndrome, or sensory motor neuropathies, such as Friedreich ataxia and Charcot-Marie-Tooth syndrome.
- Ventricular hemorrhage.
- Consanguineous marriage of parents.
- Family history of hearing loss.
- Chemotherapy.

METHODS

This prospective study was done on 4356 newborns for hearing screening by transient evoked oto-acoustic emissions in maternity ward and NICU and then BERA in those noted "refer" at retest TEOAE at RIMS, Ranchi, Jharkhand, India during the period of 18 months (June 2015-November 2016). Follow-up done by visits and phone calls. Templates were generated in MS excel sheet and data analysis was done using SPSS software (version 20). The detailed general physical examination and examination of nose, throat and ear were carried out to rule out external ear and middle ear pathology.

Exclusion criteria

Newborns once discharged and did not return, whose parents/relatives were not willing to undergo screening test for hearing, and those who expired during study period.

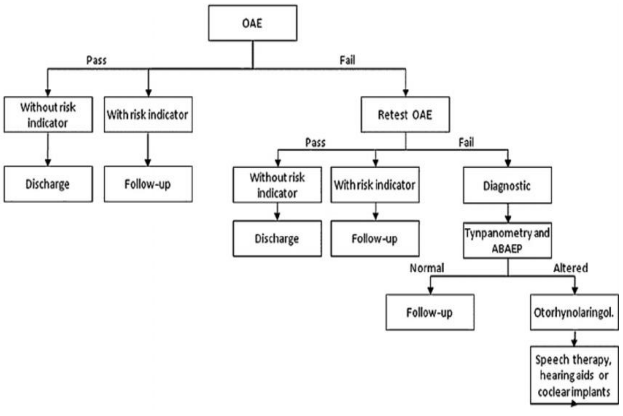

Figure 1: Pictorial view of steps followed in neonatal hearing screening.

RESULTS

Table 1 shows socio-demographic profile of newborns with hearing loss. During the period of 18 months (June 2015-November 2016) study done on 4356 newborns

showed 3.90/1000 newborns were noted "refer" on retest TEOAE. Hearing loss (BERA- Fail) is slightly more common in males (2.20/1000 newborns), of rural areas (2.44/1000 newborns), tribal ethnicity (2.75/1000 newborns) and those delivered by LSCS (4.47/1000 newborns). Hearing loss (BERA-Fail) noted in 2.07/1000 newborns. Among high risk newborns 21.41/1000 newborns were noted "refer" on retest TEOAE and 11.53 were found BERA fail (Table 2).

Table 1: Categorization on the basis of socio-demographic profile.

Criteria	Groups	Strength	Referral at 1st Screening (TEOAE)	Referral at retest TEOAE	Referral at retest TEOAE per 1000 Newborns	BERA (Fail)	BERA (Fail) per 1000 Newborns
Sex	Male	2265	91	9	3.97	5	2.20
	Female	2091	87	8	3.83	4	1.91
Residence	Urban	1893	64	6	3.17	3	1.58
	Rural	2463	114	11	4.47	6	2.44
Ethnicity	Non-Tribal	3266	122	12	3.67	6	1.83
	Tribal	1090	56	5	4.59	3	2.75
Mode of delivery	Normal vaginal delivery	2789	83	7	2.51	2	0.72
	Lower section caesarean section (LSCS).	1567	95	10	6.38	7	4.47
Total		4356	178	17	3.90	9	2.07

Table 2. Categorization on the basis of association with high risk factors.

Criteria	Groups	Strength	Referral at 1st Screening (TEOAE)	Referral at Retest TEOAE	Referral at retest TEOAE per 1000 newborns	BERA (Fail)	BERA (Fail) per 1000 Newborns
High risk factor	Associated	607	122	13	21.41	7	11.53
	Not associated	3749	56	4	1.07	2	0.53
Total		4356	178	17	3.90	9	2.07

DISCUSSION

Hearing loss (BERA-Fail) was 21.71 times more common in newborns associated with high risk factors, mainly low birth weight (<1.5 kg), preterm birth (<32 weeks), NICU stay >5days, Neonatal jaundice, birth asphyxia, low Apgar score.[8,9] Khairi et al found the following risk factors for hearing impairment in a population of newborn of high risk: craniofacial malformations, low weight at birth, ototoxic drugs, syndromes associated with the hearing loss and hyperbilirubinemia .In this study 5 cases of cranio-facial anomaly (cleft lip & cleft palate) were found with Normal hearing (i.e pass on Retest OAE).[10] Wroblewska-Seniuk et al found a prevalence of 3.56% of hearing loss in newborns from common nursery when compared to 24.9% of high risk newborns. Higher cases of newborns with hearing loss from rural areas and tribal background was mainly attributed to lack of regular antenatal checkups, lack of proper nutrition, lack of immunization as per schedule, low concern about health issues, consanguineous marriage, little knowledge of family planning. Newborns delivered by LSCS were found to have higher incidence of hearing loss (6.20 times) than those by normal delivery.[11]

CONCLUSION

High risk newborns had much higher risk of hearing loss (more than 20 times). False positive results may be due to fluid from the birth canal may still be present in the ear canal, excessive noise or movement of the infant during the test and presence of wax in ear. The majority of 'REFERs' comes from NICU population and many of these families live far away from the centre and in the remote areas. 'case leakage' or 'non-adherence' appears to be a problem that needs to be addressed somehow.[12]

The core goals are described as "1-3-6" goals.

1- Infants to be screened by 1 month of age.

3- Audiological assessment completed by 3 months of age.

6- Initiation of appropriate medical and audiological, and early Interventional services by 6 months of age.

Interventions can vary from sign language to cochlear implantation. Under ADIP scheme one of the major initiative of the Ministry of Social Justice and Empowerment, Govt. of India include assistance ranging from free hearing aids to cochlear implant at subsidized rates. Ministry of Social Justice and Empowerment will recognize an Institute of national stature from each zone to recommend children eligible under the Scheme for cochlear implant, with a ceiling of Rs.6.00 lakh per unit to be borne by the Government. 0.53/1000 newborns without any associated high risk factors had hearing loss (BERA-Fail), indicating 1 in every 2000 newborns without any high-risk factors had hearing loss. So, under the aegis of National Programme for Prevention and Control of Deafness (NPPCD) of India universal screening of all Newborns can and should be applied to decrease the burden of deafness in our society. "Catch them young" should be the central theme of any program for the control of deafness. From the last few years we are more focused on childhood hearing.[13] The theme for World Hearing Day 2016 was 'Childhood hearing loss: act now, here is how!' This drew attention to the fact that the majority of causes which lead to hearing loss in children can be prevented through public health measures. Every child is precious and hearing is their fundamental right.

ACKNOWLEDGEMENTS

Authors are thankful to their faculty members for their proper guidance and the staffs of ENT department, Paediatrics department, Obstetrics and Gynaecology department RIMS for their support and help.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Burke MJ, Shenton RC, Taylor MJ. The economics of screening infants at risk of hearing impairment: An international analysis. Int J Pediatr Otorhinolaryngol. 2012;76:212-8.
2. Karaca ÇT, Oysu Ç, Toros SZ, Naiboğlu B, Verim A. Is hearing loss in infants associated with risk factors? Evaluation of the frequency of risk factors. Clin Exp Otorhinolaryngol. 2014;7(4):260-3.
3. Bhattacharyya N, Meyers AD, Auditory Brainstem Response Audiometry. 2017. Available from: http:// emedicine.medscape.com/ article/ 835943-overview.
4. Thirunavukarasu R, Balasubramaniam GK, R Kalyanasundaram RB, Narendran G, Sridhar S. A study of brainstem evoked response audiometry in high-risk infants and children under 10 years of age. Indian J Otol. 2015;21(2):134-7.
5. JCIH. Year 2000 position statement: principles and guidelines for early hearing detection and intervention programs. Joint Committee on Infant Hearing, American Academy of Audiology, American Academy of Pediatrics, American Speech-Language-Hearing Association, and Directors of Speech and Hearing Programs in State Health and Welfare Agencies. Pediatrics 2000;106(4):798-817.
6. Shahnaz P, Bijan K, Narjes P, Ali J. Prevalence of hearing loss in newborns admitted to neonatal intensive care unit. Iranian J Otorhinolaryngol. 2012;24(3):68.
7. American Academy of Pediatrics, Joint Committee on infant hearing 2007. Position statement: Principles and guidelines for early hearing detection and intervention programme. Pediatrics. 2007;120(4):898-921.
8. Scott-Brown's Otorhinolaryngology, Head and Neck Surgery. 7th ed. London: Edward Arnold Publishers Ltd.; 2008;3:3290-1.
9. Khairi MD, Din S, Shahid H, Normastura AR. Hearing screening of infants in neonatal unit, Hospital Universiti Sains Malaysia using transient evoked otoacustic emissions. J Laryngol Otol. 2005;119(9):678-83.
10. Wroblewska-Seniuk K, Chojnacka K, Pucher B, Szczapa J, Gadzinowski J, Grzegorowski M. The results of newborn hearing screening by means of transient evokes otoacustic emissions. Int J Pediatr otorhinolaryngol. 2005;69(10)1351-7.
11. Zakzouk S. Consanguinity and hearing impairment in developing countries: a custom to be discouraged. J Laryngol Otol. 2002;116(10):811-6.
12. Universal Newborn Hearing Screening Programme. 2014. Available from: https:// www.nsu.govt.nz/ pregnancy-newborn-screening/ universal-newborn-hearing-screening-programme.
13. 3 March 2016: World Hearing Day. Report of activities. Available from: http:// www.who.int/ pbd/ deafness/ world-hearing-day/ 2016/en/.

Cite this article as: Singh PK, Kumar N, Kumar D, Shrivastava N, Kumar A. A prospective study for hearing screening of 4356 newborns by transient evoked oto-acoustic emissions and brainstem evoked response audiometry: a study of high risk factors for hearing loss. Int J Res Med Sci 2017;5:1554-7.