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EVALUATION OF RISK FACTORS ON HEARING ABILITY IN INFANTS AT RISK BY BERA

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ABSTRACT

Incidence of severe hearing loss among survivors of neonatal intensive care who are exposed to multiple risk factors ranges from 1% to 28%. So the present study is done to know the incidence of hearing loss in infants at risk and to evaluate the effect of risk factors on hearing. 128 risk infants exposed to multiple risk factors viz; prematurity, birth asphyxia, LBW , hyperbilirubinemia and neonatal seizures were evaluated using RMS EMG. EP MARK –II machine . On multiple logistic regression analysis however only hyperbilirubinemia was found to be significantly correlated (p-value <0.05) with hearing impairment in the affected infants and infants without neonatal seizures showed protection from deafness signifying that it is a risk factor for deafness. Screening of high risk infants by BERA at the earliest will help in their rehabilitation and normal developmental milestones.

KEY WORDS: **Neonates; prematurity; hyperbilirubinemia; BERA; deafness**

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INTRODUCTION

Autonomic neuropathy/autonomic dys-synchrony (AN/AD) is not a newly known disorder ,but recently it has been possible to more accurately assess and understand it. Autonomic neuropathy is defined as hearing impairment with normal outer hair cells and cochlea ,but impaired neural condution in auditory pathways.This condition (or other conditions with similar pattern) accounts for 7% of permanent childhood hearing impairments[1].The most frequent infantie problems accompanying AN/AD include anoxia and hyperbilirubinemia. Early incidence of one or both of these problems has been reported in more than 50% cases. Although some of these babies have only a transient loss, in a considerable number, hearing loss persists[2].Deafness in 1st three years of life may impair the full development and maturation of auditory system and that deafness in infancy and childhood interferes with normal development of speech and language . In the absence of normal speech, child's ability to communicate is restricted and this has a negative impact on child's social, emotional, cognitive and academic development[3]. Consequently, as a child grows into adulthood, his/her vocational and academic potential is significantly attenuated and family/society is left to bear the cost of the care of an otherwise healthy individual for life. To prevent this and to initiate rehabilitative procedure as early in life as possible a screening method to detect auditory disabilities in newborns is of great importance. Although many methods like - behavioural audiometry ,impedance audiometry, respiratory and cardiac responses and crib movement systems are evaluated, BERA which yields information on threshold sensitivity of peripheral part of auditory apparatus and on conduction velocity in brainstem[3] is the satisfactory procedure which can be performed with ease in children. So the present study is done to evaluate the relative importance of the various otonoxious risk factors like hyperbilirubinemia, birth asphyxia, low birth weight and neonatal convulsions in producing hearing impairment in infants at risk in and around Davangere city.

MATERIALS AND METHODS

In this study, an attempt is made to study the findings of BERA in infants with risk factors. 128 Infants at risk, who visited our Bapuji Child Health Institute for follow up, who were exposed to multiple risk factors viz; prematurity, birth asphyxia, LBW (<1500 gm), hyperbilirubinemia and neonatal seizures were evaluated using RMS EMG. EP MARK –II machine . Infants with History of high risk factors[4,5] – preterm, low birth weight, birth asphyxia, neonatal seizures, hyperbilirubinemia were selected for the study. All patients were administered the test procedures with prior appointment.Prior to the test an ENT check up was done to rule out the possibility of wax, ear infection, middle ear problems etc. Prior to the test, each child was examined by the pediatrician and the dosage for sedation was prescribed. Drug used for sedation was syrup Triclofos 20mg/kg body wt. The instrument used was RMS EMG. EP MARK –II machine which is a fully computerized machine manufactured by RMS RECORDERS and MEDICARE SYSTEM Chandigarh. Test was carried out in a pre–cooled, quiet, dimly lit room with subject relaxed in supine position with eyes closed. The skin was cleaned with spirit and OMEN abrasive skin preparatory paste. The silver electrodes were placed as follows: Cz–vertex, both mastoid, (Ai and Ac) forehead (ground). Resistance was not more than 1ohm. Electrodes were fixed using RMS recording paste which gives least resistance and is easy to use in terms of any allergies, cleaning and cost effectiveness. Acoustically shielded THD 32 ear phones were placed in the ear and head bands were adjusted. Monoaural auditory stimulus consisting of rare faction clicks of 100 microseconds with intencies starting from 30 dB to 110 dB were delivered through electrically shielded earphones at a rate of 11.1/sec. Contralateral ear was masked . The filter settings used were 150Hz–3000Hz. The polarity used was alternate and the analysis time was 10m/sec. About 2,000 responses were averaged. The existence of peak V was considered as sound stimulus heard and perceived by the auditory

mechanism. The threshold for each ear was confirmed. Peak V occurs around latency of 5.7 m/sec with S.D. of 0.25 (as per our norms).

RESULTS

In multiple logistic regression analysis however only hyperbilirubinemia was found to be significantly correlated (p-value <0.05) with hearing impairment in the affected infants and infants without neonatal seizures showed protection from deafness signifying that it is a risk factor for deafness. Out of 128 cases 92 had abnormal BERA findings signifying disability persisting in future. Out of(table 1) 52 hyperbilirubinemia infants, 31(59.6%) had hearing impairment. Exact significance was .010 by Chi square tests(table 2). Odds ratio was .382, Confidence of the interval was.172-0.849(table 7).Out of 27 neonatal convulsions 16 (59.3%)had a hearing impairment(table 3). Exact significance was .083 by Chi square tests(table 4). By nominal regression, marginal percentage of hyperbilirubinemia cases with deafness was 40.6% (table 5) and for neonatal convulsions it was 21.1%. Significance by likelihood tests was found to be 0.017for hyperbilirubinemia and .182 for neonatal convulsions(table 6).Odds ratio was .532 ,Confidence of interval was .213-1.329(table 7). Out of(table 8) 37 low birth weight cases 30 had some hearing abnormality which was statistically not significant. Out of(table 9) 40 birth asphyxia cases 29 had hearing abnormality which was also not significant. Of 128 total cases we had(table 10) 28 preterm cases among which we had some hearing abnormality in 17 cases. All the above cases were sent for further rehabilitative procedures as per their requirement.

DISCUSSION

Schulman – Galambos and Galambos[6] studied 325 children with BAEP 1year or more after discharge from their intensive care nursery . They found 8 children (2.14%) with severe hearing loss. Galambos et al [7] in a more recent large follow up study continues to maintain a higher incidence of significant hearing loss of 4-9%. Roberts et al [8] in another recent large follow up study could confirm hearing loss in only 2.3% therefore this issue remains controversial[9]. Study by Ira Bergman [10] shows that the frequency of hearing loss among surviving and followed LBW infants was 9.7%, among survivors of neonatal seizures it was 16.7% and confirms the high frequency of hearing loss among surviving VLBW premature infants and highlights the fact that 61% of these children are otherwise neurologically and intellectually intact. BAER was abnormal in 22/30 neonates (73.3%) with risk factors[11]. In our study, we found BAER was abnormal in 92/128 (tab.5).Out of 593 children (0-5 year) from High Risk category subjected to B.E.R.A. Over last 5 years, 126 (21.4%) showed hearing loss. 202 children (34.06%) from Birth Asphyxia category formed the largest group[12] .But in our study hyperbilirubinemia formed the largest group.Thirteen (19.2%) of 68 at risk neonates in an intensive care nursery with one or more adverse perinatal clinical factors were diagnosed to have hearing impairment by BERA testing. Among risk factors only 2 factors have been significantly correlated with hearing impairment in the affected neonates (viz; hyperbilirubinemia at level exceeding indication for exchange transfusion and birth weight <1500gm[13] .Compared to this we had one common factor that is hyperbilirubinemia which showed significant correlation. In our study out of 37 low birth weight cases 30 had hearing impairment but the significance by Chi-square test was .102 which was statistically not significant . Since most of the survivors in neonatal intensive care units have one or more identified high risk factors , their BERA testing at the time of discharge is justified as a screening procedure for early detection of hearing impairment[13]. According to Salamy A et al[14] hearing evaluation for high – risk infants throughout the first few years of life is imperative. They conclude that protracted illness constitute important risk factor for permanent hearing loss and for transient hearing loss in early life. According to Chadha et al incidence of significant auditory impairment was 18% ,on the basis of this study it is suggested that all high risk neonates should undergo screening for hearing impairment [15].Bergman et al found that the frequency of hearing loss among

surviving and followed low birth weight infants was 9.7%,among survivors of neonatal seizures 16.7%, and among LBW infants with neonatal seizures 28.6%.By history, all hearing loss appeared to date from infancy and was nonprogressive[16]. Dorothy et al[17] found the sensitivity of BAEP as a screening test to be 100% , specificity of the test is 86% . With further experience and technologic advances , BAEP may prove justified for wide-spread clinical utilization in the hearing screening of high –risk newborns. By this study, we can observe that infants exposed to risk factors like prematurity , neonatal jaundice, neonatal convulsions , birth asphyxia and LBW are prone for some hearing abnormality which correlates with earlier school of thoughts as quoted below. Among these risk factors in our study we observed neonatal convulsions, birth asphyxia and neonatal jaundice carry a very high risk of hearing abnormality. Previous studies [18] have found either that many individual neonatal variables such as high serum bilirubin concentration ,low Pao2 or cyanotic attacks were associated with hearing loss. Bilirubin can deleteriously affect the auditory pathway anywhere along its course in the brain stem ,although the cochlear nucleus is usually most involved[19,20]. Animal studies[21] suggest that acoustic trauma and aminoglycosside antibiotics may act synergistically to produce hearing loss in premature animals. Hypoxemia has been identified as a possible ototoxin according to Duara S et al[22]. Leech et al [23] concludes that brainstem auditory nuclei are particularly susceptible to acute hypoxic insults in the neonate. So this hearing impairment has to be detected in the early stages and proper rehabilitative measures are taken at the earliest so that further developmental milestones are not delayed . BERA as a screening procedure will give an idea of degree of hearing impairment. It is suggested that all the risk factors which bring the neonate under intensive care induces a certain amount of hypoxia of the cochlea and brainstem, which leads to various cellular changes such as edema, degeneration and necrosis. Hence they predispose to hearing impairment ,which may be reversible following reversal of the hypoxic changes.[2] Itknur kilic et al concludes that there were no significant differences for latencies and interpeak latencies between term and preterm groups at the same postconceptional age.They found that type of delivery(caesaerean section),birth weight <1500g, hyperbilirubinemia exceeding phototherapy limits and low Apgar scores affected some of the BAER parameters($p<0.05$)[24] . It is suggested that all of the risk factors which bring the neonate under intensive care induce a certain amount of hypoxia of the cochlea and brainstem , which leads to various cellular changes such as edema ,degeneration and necrosis. Hence, they predispose to hearing impairment , which may be reversible following reversal of the hypoxic changes[24]. In Gupta et al's study birth weight ,1500g was significantly correlated with the hearing impairment but birth asphyxia had no significant correlation with hearing impairment.[14]In our study in both low birth weight and birth asphyxia no statistically significant hearing impairment was found. Jiang et al reported that the preterm babies with perinatal complications had a significant increase in wave V latency, I-V and III-V intervals , and III-V/I-III interval ratio[25]. Galambos and Despland concluded that perfusion of the cochlea with blood low in pH(<7.25) in the first 2 hours after birth or on two more occasions was important precursor to hearing loss[26].

TABLE 1
Crosstab- Neonatal Jaundice

			Deafness		Total
			0	1	0
Neo Jaundice	0	Count	15	61	76
		% within Neo Jaundice	19.7%	80.3%	100.0%
	1	Count	21	31	52
		% within Neo Jaundice	40.4%	59.6%	100.0%
Total		Count	36	92	128
		% within Neo Jaundice	28.1%	71.9%	100.0%

Neo Jaundice 0- no, 1-yes. Deafness 0-no, 1-yes.

TABLE 2
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.512(b)	1	0.011		
Continuity Correction(a)	5.530	1	0.019		
Likelihood Ratio	6.442	1	0.011		
Fisher's Exact Test				0 .016	0 . 010
Linear-by-Linear Association	6.461	1	0.011		
N of Valid Cases	128				

a Computed only for a 2x2 table
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 14.63.

TABLE 3
Crosstab- Neonatal Convulsions

			Deafness 0	Deafness 1	Total 0
Neo.Convulsions	0	Count	25	76	101
		% within Neo.Convulsions	24.8%	75.2%	100.0%
	1	Count	11	16	27
		% within Neo.Convulsions	40.7%	59.3%	100.0%
Total		Count	36	92	128
		% within Neo.Convulsions	28.1%	71.9%	100.0%

Neo Convulsions 0-no, 1-yes. Deafness 0-no, 1-yes.

TABLE 4
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.694(b)	1	0.101		
Continuity Correction(a)	1.961	1	0.161		
Likelihood Ratio	2.560	1	0.110		
Fisher's Exact Test				0.147	0.083
Linear-by-Linear Association	2.673	1	0.102		
N of Valid Cases	128				

a Computed only for a 2x2 table
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.59.

TABLE 5
Case Processing Summary

		N	Marginal Percentage
Deafness	0	36	28.1%
	1	92	71.9%
Neo. Convulsions	0	101	78.9%
	1	27	21.1%
Neo Jaundice	0	76	59.4%
	1	52	40.6%
Valid		128	100.0%
Missing		0	
Total		128	
Subpopulation		4	

Deafness 0-no,1-yes. Neo Convulsions 0-no, 1-yes. Neo Jaundice 0- no, 1-yes.

TABLE 6
Likelihood Ratio Tests

Effect	Model Fitting Criteria -2 Log Likelihood of Reduced Model	Likelihood Ratio Tests Chi-Square	df	Sig.
Intercept	16.557(a)	.000	0	.
Neo Convulsions	18.341	1.783	1	.182
Neo Jaundice	22.223	5.666	1	.017

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0. a This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

Table 7

	Odds ratio	df	CI (95%)
Neonatal convulsions-NO Neonatal convulsions-YES	0.532	1	0.213-1.329
Neonatal jaundice-NO Neonatal jaundice-YES	0.382	1	0.172-0.849

df- degree of freedom ***CI-confidence interval***

TABLE 8
Crosstab- Birth Weight

			Deafness 0	Deafness 1	Total 0
Birth Weight	1	Count	7	30	37
		% within Birth Weight	18.9%	81.1%	100.0%
	2	Count	29	62	91
		% within Birth Weight	31.9%	68.1%	100.0%
Total		Count	36	92	128
		% within Birth Weight	28.1%	71.9%	100.0%

Birth Weight 1-<1500gm, 2->1500gm. Deafness 0-no, 1-yes.

TABLE 9
Crosstab-Birth Asphyxia

			Deafness 0	Deafness 1	Total 0
B.Asphyxia	0	Count	25	63	88
		% within B.Asphyxia	28.4%	71.6%	100.0%
	1	Count	11	29	40
		% within B.Asphyxia	27.5%	72.5%	100.0%
Total		Count	36	92	128
		% within B.Asphyxia	28.1%	71.9%	100.0%

Birth Asphyxia 0-no ,1-yes . Deafness 0-no, 1-yes.

TABLE 10
Crosstab-Term and Preterm

			Deafness		Total
			0	1	0
Term	1	Count	25	75	100
		% within Term	25.0%	75.0%	100.0%
	2	Count	11	17	28
		% within Term	39.3%	60.7%	100.0%
Total		Count	36	92	128
		% within Term	28.1%	71.9%	100.0%

Term 1->28weeks,2-<28weeks. Deafness 0-no, 1-yes.

CONCLUSION

BERA is the only objective method which can confirm the normal sensitivity of hearing whenever required and is very useful in early detection of hearing loss and also helps in knowing the exact hearing level thereby plays important role in planning rehabilitative procedures. In case of multiple handicaps, BERA is the only test which can give an accurate picture of hearing sensitivity. In case of high risk babies who are exposed to multiple risk factors like neonatal jaundice, neonatal convulsions , birth asphyxia, prematurity and LBW and even other multiple risk factors which have chances of impairing hearing ability, BERA should be carried out as a routine procedure to detect the hearing threshold in such babies. Since it is a study with multiple risk factors, further studies are needed with a single risk factor and their association for the hearing disability.

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Conflict of Interest:
Conflict of interest declared none.

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