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Original Articles

AUDITORY BRAINSTEM RESPONSES (ABR) IN HYPERBILIRUBINEMIC NEWBORNS

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ABSTRACT

To evaluate the changes of ABR values in hyperbilirubinemic newborns, 85 cases with severe jaundice (total bilirubin levels over 16 mg/dL and direct bilirubin less than 2 mg/dL) were selected from those admitted to Children's Medical Center by simple sampling method. These infants had no other problem except jaundice. ABR was taken before treatment in all cases and in some (10 cases) after exchange transfusion or phototherapy as treatment modalities. 41 neonates (48%) had abnormal ABR values, such as increased hearing threshold, prolonged latencies of waves I, III & V (p- value<0.05), prolonged interpeak latencies of I-V & III-V (p-value<0.05), absence of waves and abnormal wave morphology. These findings could be indicative of both peripheral (8th nerve) and brainstem disturbances. After treatment ABRs showed improvement in some aspects, such as latencies of waves I, III & V (p value<0.05), but not in interpeak latencies (I-III, III-V & I-V) and hearing thresholds. In accordance with previous studies, there was no association between serum total bilirubin concentration and ABR test results. This could be interpreted as low significance of serum total bilirubin as a criterion for early prediction of bilirubin induced encephalopathy.

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Keywords: ABR, Hyperbilirubinemic newborn, Total serum bilirubin.

INTRODUCTION

The data indicate that brainstem evoked response audiometry is a sensitive technique for detecting bilirubin neuronal disturbance and perhaps imminent neuronal injury. The technique holds considerable promise for early identification of the infants at risk for neuronal injury. ABR is also useful in the long term followup of residual hearing deficits and also as an objective test for investigational aspects, e.g. pathogenesis of bilirubin neurotoxicity.[1,3]

The auditory pathway of the neonate is particularly vulnerable to bilirubin insult and the damage may result in permanent sensorineural hearing loss, because bilirubin pathologically stains selective subcortical nuclei including the auditory pathway. The hearing deficit, even when severe, very often escapes clinical detection for months or even longer and this may be reflected in delayed acquisition of language.[3]

MATERIAL AND METHODS

In a 9 month (January to December 1999) prospective case series study, we evaluated the abnormal changes of ABR values in hyperbilirubinemic newborns and its reversibility following phototherapy or exchange transfusions. Moreover, we compared the serum total bilirubin with

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abnormal auditory brainstem responses or in other words probable hyperbilirubinemia induced neurotoxicity. The inclusion criteria for our study were:

1) Total bilirubin concentrations above 16mg/dL and direct bilirubin less than 2mg/dL.

2) Gestational age between 32 and 42 weeks by date confirmed by clinical assessment.

3) Birth weights and head circumferences appropriate for gestational age.

4) Uncomplicated pregnancy and delivery.

5) Absence of congenital anomalies.

6) First minute APGAR score more than 7.

7) No family history of deafness.

8) Uncomplicated neonatal course.

9) Absence of neonatal sepsis.

The first auditory brainstem response study was performed before the therapeutic intervention (i.e. phototherapy and/or exchange transfusion). The second ABR was performed after a mean period of 6 days following the first one for those accessible icteric newborns who had a first abnormal ABR. Simultaneously serum samples were obtained for measurement of total and direct bilirubin.

ABR was measured with a Neuropack-2 Nihon Cohden machine. Rarefaction click stimuli were delivered through a headphone binaurally as well as monaurally. We did it in different intensities up to 105 dB and 2000 stimuli in 150-1500 Hz band-pass. Brainstem responses were detected and monitored by a vertex electrode in the first 10 msec after each stimulus and then all the responses gathered were averaged by computer to produce ultimately the five components of classic waves.

Latencies of waves I, III & V, interpeak latencies of I-III, I-V & III-V, amplitude of the main waves, V/I ratio and hearing threshold (HT) were also measured. An ABR test result was considered abnormal if:

1) Prolongation of waves I, V or I-V, I-III interpeak latencies (>2SD of normal value).

2) Suppression of waves I, III, V amplitude (<2SD of normal value), or

3) Increased hearing threshold in one or both ears was observed.

RESULTS

85 icteric newborns, 51 (60%) male, 34 (40%) female were selected by simple sample method. The mean of postnatal age, gestational age, birth weight and total bilirubin (direct bilirubin) were 6.7 days, 38.7 weeks, 3142 g and 19.8 mg/dL (1.1 mg/dL) respectively. 63 newborns (74%) underwent phototherapy while the other 22 newborns (26%) had exchange transfusion.

41 icteric newborns (48% of total) had aberrations of auditory brainstem responses in their first ABR test. Prolonged wave latencies are well shown in Fig. 1.

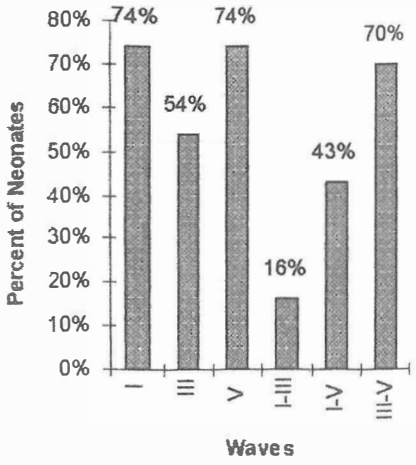


Fig. 1. Prolonged latency of ABR test in icteric neonates. 38 icteric neonates (92%) had HT above 20 dB.

Comparing with normal values, we found that latencies of waves I, III, V and interpeak latencies of I-V and III-V have been prolonged compared to normal values (p-value <0.05).

Hearing threshold has been increased compared to normal values (p-value <0.05).

Interpeak latency I-III had no significant difference compared to normal values.

To evaluate the reversibility of ABR changes after therapeutic measures, ABR testing was performed again in 10 accessible neonates whose first ABR test had been abnormal. The second test was accomplished in a mean interval of 6 days. Then we evaluated the hypothesis of improving wave latencies and hearing threshold following phototherapy or exchange transfusion. (Table I, Fig. 2).

Comparison of aberrations in two consecutive ABR tests of 10 icteric newborns shows improvement of wave latencies I,III, and V in the second ABR (p-value <0.05).

There was no significant difference in interpeak latencies of I-V , III-V and HT between the two ABR tests.

For evaluating the relation between serum total bilirubin and values of ABR, hyperbilirubinemic newborns were divided into 3 groups as below:

1) Group A: Total bilirubin <18.5 n=20

2) Group B: 18.5<Total bilirubin<20 n=34

3) Group C: Total bilirubin >20 n=31

Mean and standard deviation of age, gestational age, birth weight and total bilirubin of these 3 groups are depicted in Table II.

Modality of treatment and ABR test results are shown in

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Table I. Comparison of latencies and HT in two consecutive ABR tests (before and after treatment) in 10 icteric neonates.

Waves	Mean ±SD in first ABR	Mean ±SD in second ABR
Latency I	2.53±0.61	1.92±0.23
Latency III	5.29±0.59	4.67±0.37
Latency V	8±0.53	7.27±0.56
Interpeak I-III	2.78±0.38	2.57±041
Interpeak I-V	5.47±0.44	5.32±0.61
Interpeak III-V	2.71±0.34	2.55±0.32
HT	52±12.52	40±18.26

Mean ±SD of total bilirubin for the first and second ABR test were 20.2±1.9 and 8.8±1.7 respectively.

Table II. Mean ±SD of age, gestational age, birth weight and total bilirubin of the 3 groups.

	Group A	Group B	Group C
Age (day)	8.5±3.5	7±3.2	7.7±2.7
Gestational age (w)	38.2±1.4	39.2±1	38.7±1.3
Birth weight (gr)	3012±523	3211±379	3151±466
Total bilirubin (mg/dl)	17.5±0.7	18.9±0.4	22.2±2

These 3 groups had no significant difference in the variables mentioned above.

Table III and Fig. 3.

Using chi-square test for evaluating the serum total bilirubin as a criterion for the risk of bilirubin encephalopathy, we concluded that there was no association between the level of serum total bilirubin and ABR test results.

DISCUSSION

In this study which involves 85 hyperbilirubinemic newborns, 48% of pretreatment ABR values were abnormal. Since these icteric infants were presumably free of any pathologic process, it is more probable that the observed abnormality in the ABR waves was due to pure bilirubin induced neurotoxicity. Aberrations of auditory brain stem responses were as follows: [1,3,4,5,6]

- Increased hearing thresholds
- Prolongation of wave latencies I, III, and V
- Prolongation of interpeak latencies I-V, and III-V
- Absence of some waves and abnormal morphology

These findings are indicative of both peripheral and brainstem disturbances and correlate with neuropathologic findings indicative of injury to auditory and cochlear nuclei and inferior colliculi.[1,3]

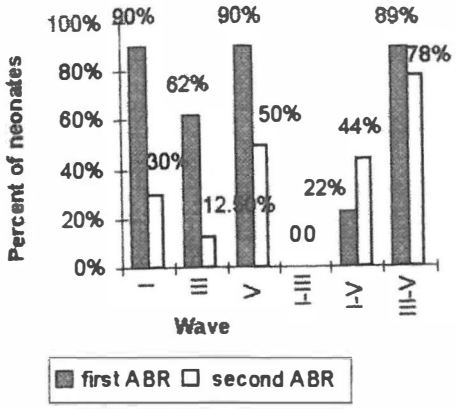


Fig. 2. Comparison of prolonged latencies in 2 consecutive ABRs.

Table III. Modality of treatment.

Type of Treatment	Group A	Group B	Group C
Phototherapy	20(100%)	32(94%)	11(35.5%)
Exchange transfusion	0	2(6%)	20(64.5%)

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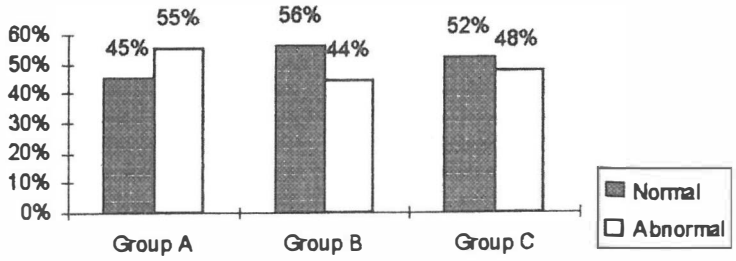


Fig. 3. ABR test results.

Improvement of wave latencies following treatment modalities indicates the impression of therapeutic measures on the acute hyperbilirubinemic encephalopathy while the level of serum bilirubin decreases. Unimproved hearing threshold and interpeak latencies in the second ABR warrant prolonged follow up and repeated ABR test(s) for evaluating residual deficits and rapid interventions if necessary.

In accordance with previous studies and based on our work, there was no association between serum total bilirubin concentrations and ABR test results. In other words serum total bilirubin cannot be used as a valid criterion for early prediction of bilirubin-induced encephalopathy. So researches concerning alternative risk criteria, such as unbound bilirubin should be a future priority in this field.[7,8]

Finally we recommend ABR as a screening hearing test in neonates who meet high-risk criteria for hearing loss, e.g. hyperbilirubinemic newborns in the first 6 months of life, and also to refer those with abnormal results for further audiologic, speech and language evaluations, followup and rehabilitation as deemed necessary.[1,3,4,5,6]

REFERENCES

1- Krumholz A: Evoked potentials in infancy and childhood. In: Niedermeyer E, Lopes Da Silva F, (eds.), Electroencephalography. Baltimore: Williams &Wilkins,1993.

2- Chiappa KH: Evoked Potentials In Clinical Medicine. Philadelphia: Lippincott -Raven, 1997

3- Volpe J: Bilirubin and brain injury. In: Volpe J, (ed.), Neurology of the Newborn. Philadelphia: W.B. Saunders, 1995.

4- Nakamura H Takada S, Shimbuku R, Matsuo M, Matsuo T, Negeshi H: Auditory nerve and brainstem responses in newborn infants with hyperbilirubinemia. Pediatrics 75(4): 703-8, 1985.

5- Wennenberg PR, Ahlfors E, Bickers R, Mc Murtry A, Shetter L: Abnormal auditory brainstem responses in a newborn infant with hyperbilirubinemia: improvment with exchange transfusion. J Pediatr 100(4): 624-6, 1982.

6- Perlman M, Fainmesser P, Somber H, Tamari H, Wax Y, Pevmer B: Auditory nerve-brainstem evoked responses in hyperbilirubinemic neonates. Pediatrics 72 (5): 658-64, 1983.

7- Tan KL, Skur BA, Yip YY: Phototherapy and the brain-stem auditory evoked response in neonatal hyperbilirubinemia. J Pediatr 120 (2): 306-8, 1992.

8- Funato M, Teraoka S, Tamai H, Shimida S: Vigintiphobia, unbound bilirubin and auditory brainstem responses. Pediatrics: 93 (1): 50-3, 1994.

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