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No close correlation between brainstem auditory function and peripheral auditory threshold in preterm infants at term age

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Abstract

Objective: To determine whether central auditory function in preterm infants correlates with peripheral auditory threshold and whether threshold elevation affects central auditory function.

Methods: Brainstem auditory evoked response (BAER) was recorded at term age using maximum length sequence (MLS) with 91–910/s clicks in 133 preterm infants (gestation 28–36 weeks). The relationship between MLS BAER variables and BAER threshold was analyzed.

Results: The latencies and amplitudes of all MLS BAER waves correlated significantly with BAER threshold. However, no correlation was found between MLS BAER interpeak intervals and BAER threshold at any rates. In preterm infants with a threshold >20 dB *n*HL ($n = 30$), MLS BAER wave latencies were all significantly longer than in those with a threshold $\leqslant$20 dB *n*HL ($n = 103$) ($P < 0.01$–0.001). MLS BAER wave amplitudes were significantly smaller than in those $\leqslant$20 dB *n*HL ($P < 0.05$–0.001). However, no interpeak intervals differed significantly between the two groups of infants. V/I amplitude ratio was similar in the two groups. These findings were true of all click rates. Click rate-dependent changes in MLS BAER of the preterm infants with an elevated BAER threshold are generally similar to those with a normal threshold.

Conclusions: Brainstem auditory function does not closely correlate with peripheral auditory threshold at term in preterm infants. Elevation in peripheral threshold due to middle ear disorders does not significantly affect functional status of the auditory brainstem.

Significance: Short term peripheral conductive auditory abnormality does not significantly affect the immature central auditory function.

Keywords: Auditory function; Hearing impairment; Brainstem auditory evoked response; Evoked potentials; Preterm infant

1. Introduction

Peripheral auditory problems, typically otitis media, in infants reduce the transmission of external acoustic stimuli to the central auditory system, and thus may affect functional status and development of the system. Preterm infants are known to be at risk for peripheral auditory problems (conductive, sensory or sensorineural). These infants may also be at risk for central auditory abnormality (Jiang et al., 2002). It remains to be determined whether central auditory function in preterm infants has any correlation with peripheral auditory function and whether transient peripheral auditory abnormality has a significant effect on central auditory function.

The threshold in the brainstem auditory evoked response (BAER), a widely used tool to detect and diagnose peripheral and central auditory abnormalities in infants (Chiappa, 1990; Eggermont and Salamy, 1988; Wilkinson and Jiang, 2006), gives a good objective estimate of the amount of peripheral auditory abnormality, or hearing loss. A recent study of the BAER with 21/s clicks at term age in preterm infants found no significant correlation

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between interpeak intervals and BAER threshold (Jiang and Wilkinson, 2006). However, it is unclear whether this finding is true of higher presentation rates of clicks and whether click rate-dependent changes are affected by short term or transient elevation of the threshold.

The maximum length sequence (MLS) BAER can present the click stimuli at much higher repetition rates (up to 1000/s or even higher) than possible using conventional averaging techniques which have a rate limit of about 100/s (Eysholdt and Schreiner, 1982; Jirsa, 2001; Lasky, 1997; Lina Granade et al., 1994; Picton et al., 1992). In the last several years, the MLS BAER has been used to study functional integrity of the auditory brainstem in infants and to improve the detection of central auditory abnormality by the BAER in some paediatric neuropathology (Jiang et al., 2000, 2003, 2005, 2007; Wilkinson et al., 2007). It is possible that a study using this relatively new technique with clicks of various high repetition rates may provide some new or more detailed information about the influence of peripheral auditory abnormality on central function that may not be shown by conventional BAER (Jiang and Wilkinson, 2006), e.g., click rate-dependent changes. Thus, we carried out a study of the MLS BAER in preterm infants to further the understanding of whether preterm infants with peripheral auditory abnormality are at higher risk of central auditory abnormality than those without peripheral abnormality.

2. Materials and methods

2.1. Subjects

We recruited 133 preterm infants, with a gestational age ranging between 28 and 36 weeks (31.3 ± 2.2), 72 boys and 61 girls. At the time of MLS BAER testing all infants were in a stable clinical condition. Due to the difficulty in identifying reliably BAER components (particularly wave I) in infants with a significantly elevation of BAER threshold, any infants who had a BAER threshold >45 dB normal hearing level (*n*HL) were excluded. All subjects were studied with MLS BAER at 37–42 week postconceptional age.

2.2. Recording of the MLS BAER

A Portable Evoked Potential System (Nicolet Biomedical Inc., Madison, WI, USA) was used for MLS BAER recording. Only the left ear was tested in all subjects to save the time of recording the MLS BAER and to keep the consistence of recording and analyzing conditions. The procedures of MLS BAER recordings were basically the same as those previously reported (Jiang et al., 2005, 2007). The repetition rates of clicks were 91, 227, 455 and 910/s in the first run, and in a reverse sequence in the second run. Click intensity was 60 dB *n*HL for all infants. The study protocols were approved by the Central Oxford Research Ethics Committee.

2.3. Determination of BAER threshold

Prior to recording the MLS BAER, peripheral threshold was obtained using conventional averaging techniques, i.e., conventional BAER, at a repetition rate 21/s to obtain the threshold. The intensity of the clicks was started at 60 dB *n*HL. If main components (waves I, III and V) in the MLS BAER could be clearly identified in the recorded waveforms, the intensity was decreased to 40 dB *n*HL, and then decreased or increased by 5-10 dB steps until no clear and reproducible wave V was identifiable in the waveforms. BAER threshold was determined by establishing the lowest intensity of the clicks which produced visible and reproducible wave V with an amplitude of 0.04–0.10 μV, measured from the peak of wave V to the immediate following through.

Of the 133 infants, 103 had a BAER threshold ⩽20 dB *n*HL (11.4 ± 4.0 dB) and 30 had a threshold >20 dB *n*HL (30.7 ± 2.6 dB), which differed significantly ($P < 0.001$). No significant differences were found between the two groups of infants in gestational age, postconceptional age at which the MLS BAER took place and gender.

2.4. Analysis of MLS BAER data

Fig. 1 shows sample recordings of the MLS BAER in a preterm infant with a normal threshold. Measurements of MLS BAER variables were the same as those previously reported (Jiang et al., 2000, 2003, 2005, 2007). Data analysis was conducted in the averaged measurements of two replicated MLS BAER recordings to each stimulus condition. The relationship of MLS BAER variables with BAER threshold was analyzed for any correlation between these.

Comparison of the data was made between the preterm infants who had BAER threshold elevation (>20 dB *n*HL) and those who had a normal threshold (⩽20 dB *n*HL) to

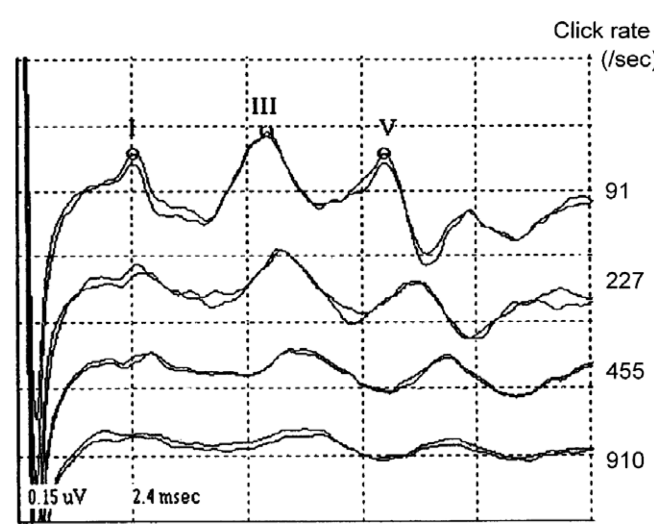

Fig. 1. Sample MLS BAER waveforms recorded from a female preterm infant (gestational age 34 weeks, postconceptional age 41 weeks). Her BAER threshold was 10 dB *n*HL.