Slow Auditory Evoked Potentials: The End of Malingering in Audiology

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Abstract: The application of slow vertex response audiometry (cortical evoked response audiometry), mainly in the diagnosis of pseudohypoacusis, is reported. This procedure is of interest in forensic audiology.

Key Words: conventional audiometry; forensic audiology; slow vertex response

In some cases, during forensic examination, defining the audiometric threshold is difficult because the patient tries to exaggerate his or her deafness. Although many techniques are available to demonstrate the existence of nonorganic hearing loss (NOHL) none of them allows us to obtain the auditory threshold exactly. Among these techniques are clinical observation of the patient, several tests of the audiometric threshold, vocal audiometry, Stenger's test, Békésy's test, stapedius reflex threshold studies, the delayed auditory feedback test, and auditory brainstem evoked potentials [1].

In 1982, a preliminary report on interest in the study of cortical evoked response audiometry (CERA; also known as *slow vertex response audiometry*) in NOHL was published [2]. Hyde et al. [3] published results confirming interest in the study of slow vertex responses in NOHL. In this article, 20 years' experience with this technique is summarized and conclusions are drawn.

MATERIALS AND METHOD

From 1987 through 2000, my colleagues and I have performed 1,200 tests on a number of subjects in whom NOHL and several cochlear pathological processes were suspected. Most of the claimants were coal miners, asking for a revalidation of their professionally incurred hypoacusis.

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Test Environment and Procedure

Subjects were tested while seated in a comfortable, relaxed position in a soundproof room, separated and isolated from the physician and apparatus. Subjects were given something to read or a video to watch and were asked to remain still during testing.

Stimulus

The testing apparatus employed was a Madsen ERA 22-50 (G.N. Otometrics, Denmark), which emitted a tone burst with a rise decay time of 5 msec and a duration of 40 msec. Frequencies were 1, 2, and 3 kHz. One stimulus was issued every 2 sec to a total of 30 stimuli. Earphones were used. Masking the nontested ear was required at high intensities (narrow band masking). The stimulus calibration was controlled the first time by an artificial ear (Bruel & Kjaer 4152 [Bruel & Kjaer, Norcross, Georgia] [4, 5]) and subsequently in comparison to normal ears. The analysis period lasted 500 msec. The bandwidth was 0.25–15.00 Hz.

RESULTS

Analysis of the Curve

In our experience, waves N1 and P2 (particularly N1) were the most reproducible until the threshold was reached (Fig. 1). Measurements always began at a 90- or 100-dB hearing level to obtain a good curve; then, in each successive trial, the level was reduced in 20-dB steps until the threshold was crossed by a clearly negative trial (i.e., the absence of a visible slow potential). At that point, we established the threshold by conducting trials in 5-dB steps.

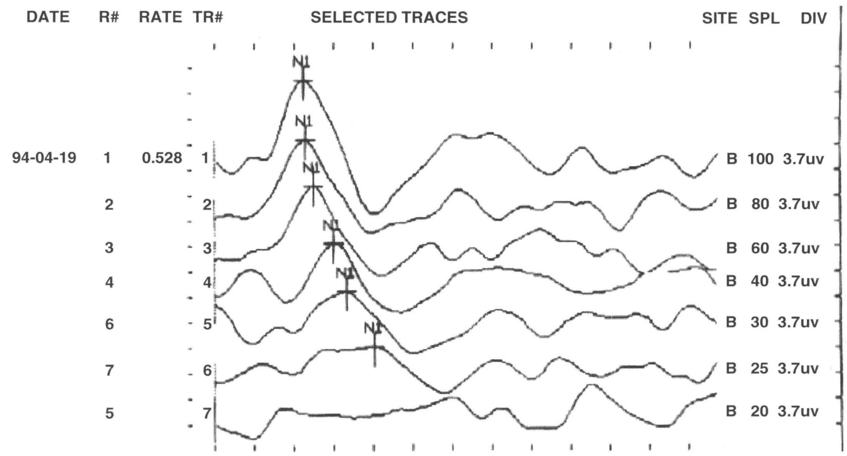

Figure 1. Results of cortical evoked response audiometry during binaural stimulation at a frequency of 1,000 Hz; an intensity of 100 dB, which was decreased in 20-dB intervals (sound pressure level); and a duration of 500 msec.

The main problem was interpreting the threshold intensity level exactly. To find this threshold most precisely, one must have good control of a patient's vigilance status because, when a patient is asleep or inattentive, threshold varies by more than 15 dB per frequency.

Patients' vigilance was best controlled by reading or video stimulation. The threshold was considered to have been reached when N1 was not reproduced by two stimulations at the same level.

Normal Subjects

When a subject's alertness was weak and attention was not sustained, threshold variability increased. In 10 normal subjects, an experiment was conducted in darkness, without any vigilance stimulation, at 1,000 Hz: The threshold for conventional audiometry and CERA varied between 10 and 20 dB, which is higher than the threshold obtained in the usual testing situation (as described in Analysis of the Curve). This finding explains why such drugs as neuroleptics and sedatives can modify the sensivity of the test, as they affect a patient's vigilance.

Subjects with Organic Hearing Loss

By averaging hearing loss in the 1,000-, 2,000-, and 3,000-Hz ranges, we compared the results of conventional (psychoacoustic) audiometry and CERA in 30 subjects who had developed hearing loss from noise exposure. A statistical analysis was conducted to compare the average of the threshold at these three frequencies as measured by the two techniques (60 measurements; Figs. 2, 3). We used Student's t-test to analyze paired cases. The average difference between conventional audiometry and CERA thresholds was 1.8 dB (standard deviation, 7.5 dB). This was not significant (p = .069) if we consider that the CERA threshold may be better or worse than the conventional audiometric threshold.

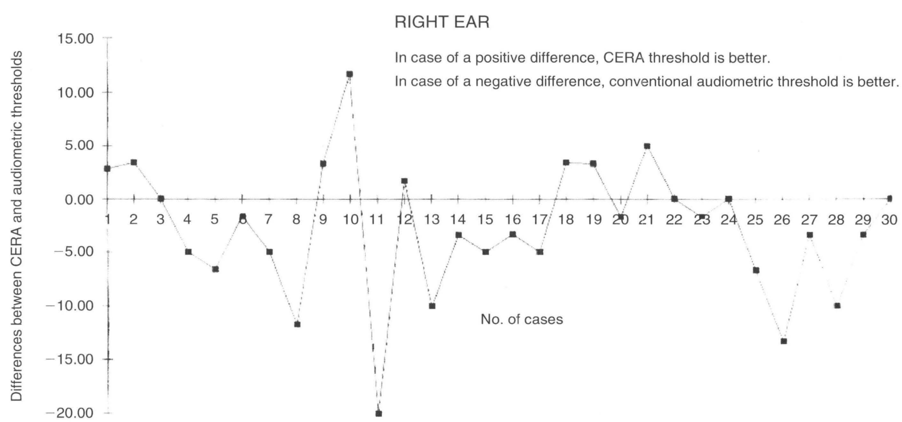

Figure 2. Differences between cortical evoked response audiometric (CERA) and conventional audiometric thresholds in the right ear of nonsimulating subjects.

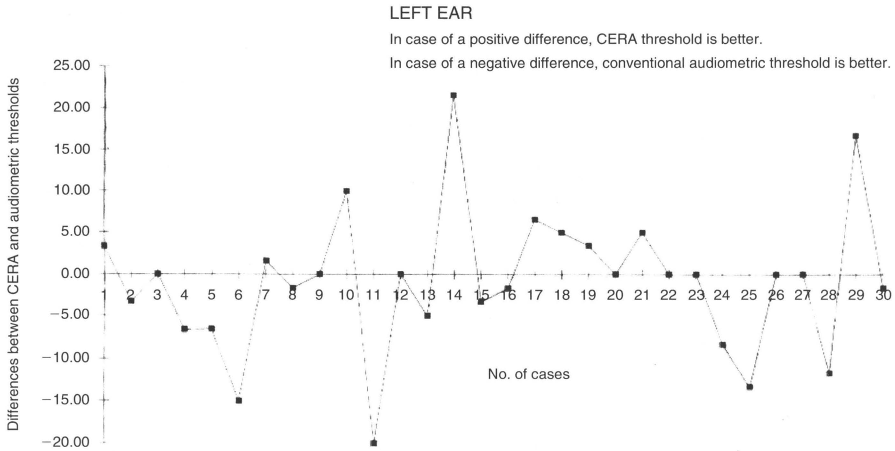

Figure 3. Differences between cortical evoked response audiometric (CERA) and conventional audiometric thresholds in the left ear of nonsimulating subjects.

Figures 2 and 3 depict the comparison among the average thresholds at 1,000, 2,000, and 3,000 kHz obtained by conventional audiometry and CERA in 30 people with NOHL. In most cases, we see that the difference between the thresholds is maximum (approximately 15 dB) except in case 11 (from two ears) and cases 14 and 29 (from one ear). Analysis demonstrated that these exceptional cases involve subjects in whom maintaining a state of vigilance was difficult.

Subjects with Nonorganic Hearing Loss (Simulating Subjects)

In our group of 87 subjects with NOHL (simulating subjects), the auditory threshold obtained by conventional audiometry and CERA was highly variable as compared to that in the group of subjects with hearing loss (Figs. 4, 5). For example, at 1,000 Hz, the average difference between conventional audiometric and CERA thresholds in the right ear was 42.1 dB (standard deviation, 16.25). Before conducting CERA in this group of subjects, we ascertained that no sedative drugs had been taken before the test and that the subjects had suffered no recent acoustic trauma.

CONCLUSION

CERA is a reproducible and reliable technique for determining the auditory threshold. When the examination conditions described in this article are achieved

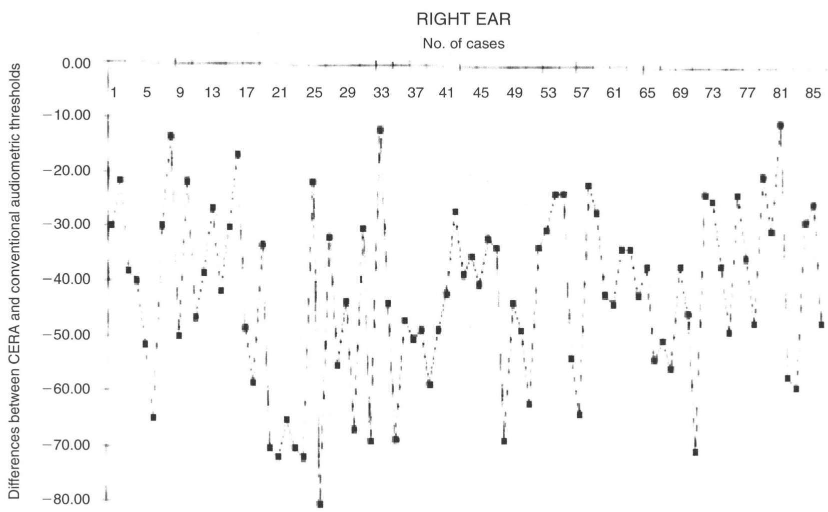

Figure 4. Differences between cortical evoked response audiometric (CERA) and conventional audiometric thresholds in the right ear of subjects with nonorganic hearing loss.

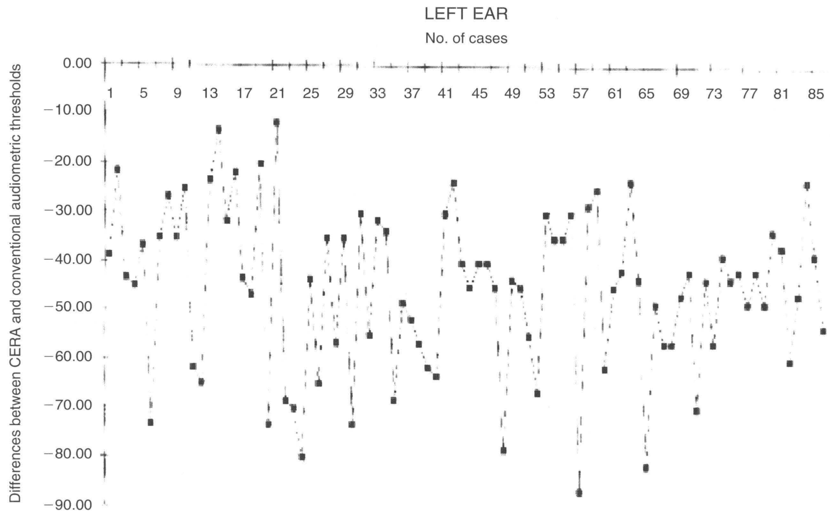

Figure 5. Differences between cortical evoked response audiometic (CERA) and conventional audiometric thresholds in the left ear of subjects with nonorganic hearing loss.

(i.e., a high level of vigilance), the precision of the CERA threshold is the same as that of conventional audiometry. The fact that the state of patients' vigilance apparently was not considered by Albera et al. [6, 7] likely explains the difference in their results, as this group found wider variability between the thresholds obtained by CERA and conventional audiometry.

Although considerable experience is required to maintain excellent examination conditions, we insist on keeping our subjects alert during the test period. In such conditions, CERA is, in our experience, the best examination for detecting NOHL. However, the cost of the necessary apparatus and the length of the examination (±1 hour) are critical factors in determining the frequency of use of this test, as its use often is not covered by third-party payers (e.g., health insurance).

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