Adults with Auditory Neuropathy: Comparison of Auditory Steady-State Response and Pure-Tone Audiometry

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Abstract

Background: The relation between the auditory steady-state response (ASSR) and behavioral audiometric thresholds requires further clarification in the case of adults with auditory neuropathy/auditory dys-synchrony (AN/AD).

Purpose: The aim of this study was to compare pure-tone audiometric threshold (PTAT) and ASSR in adults with AN/AD.

Study Sample: Sixteen adult participants (32 ears) with AN/AD, ranging in age from 14 to 34 years.

Data Collection and Analysis: PTAT and ASSR with high-rate stimulus modulation were measured at four octave frequencies, 500, 1000, 2000, and 4000 Hz, in each ear. The behavioral auditory thresholds were compared with ASSR estimated thresholds at each frequency. Analyses included comparison of group means and coefficients of correlation.

Results: The average pure-tone thresholds revealed a moderate hearing loss in the AN/AD patients with a focus on the low frequencies. Low-frequency loss audiograms were observed in almost two-thirds of the participants. The estimated auditory thresholds measured by ASSR at all frequencies were substantially higher than the PTAT measures. There were no significant correlations between the PTAT and ASSR measurements at the 1000, 2000, and 4000 Hz frequencies (p > .05); the correlation between the two measures at 500 Hz (p = .029, r = 0.39) was weak but significant.

Conclusion: There was no significant correlation between the PTAT and ASSR results at the majority of the frequencies usually tested in adults with AN/AD. Although ASSR is not a suitable method to estimate auditory thresholds in this group of patients, perhaps it can be utilized as an adjunct technique for the differential diagnosis of this disorder.

Key Words: Auditory dys-synchrony, auditory neuropathy, auditory steady-state response, pure-tone audiometry

Abbreviations: ABR = auditory brain stem response; ALR = auditory late response; AM = amplitude modulated; AMLR = auditory middle latency response; AN/AD = auditory neuropathy/auditory dys-synchrony; ASSR = auditory steady-state response; FM = frequency modulated; PTA = pure-tone average; PTAT = pure-tone audiometric threshold; WDS = word-discrimination score

Information on the hearing status of individuals suspected of auditory disorder is generally obtained via pure-tone audiometric threshold (PTAT) methods. However, it is not always possible to acquire valid or reliable information on the hearing thresholds of infants, the mentally retarded, and

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malingering or uncooperative persons (Ahn et al., 2007). In such cases it has been found useful to evaluate auditory threshold levels by means of electrophysiological procedures. One such procedure, the auditory steady-state response (ASSR), has been studied in some detail in recent years.

In the present essay we ask, What is the relation between PTAT and ASSR predictions of threshold sensitivity in adults with auditory neuropathy/auditory dys-synchrony (AN\AD)? In adults the diagnosis of auditory neuropathy is made on the basis of (1) normal otoacoustic emission and/or cochlear microphonics and (2) an absent or grossly abnormal click-evoked auditory brain stem response (ABR) at high stimulus levels (Foerst et al., 2006). It is not a new disorder but, rather, an entity that has been recognized and more readily diagnosed because of recent improvements in electrophysiologic hearing assessment methods and equipment (Ngo et al., 2006).

As it is possible for various mechanisms to have a role in this disorder, some experts consider the use of auditory neuropathy/auditory dys-synchrony (Berlin et al., 2001; Rance, 2005) as a more appropriate term. In other words, while a loss of myelin sheath can certainly affect the synchrony of neural discharges (auditory dys-synchrony), some of the other mechanisms considered to result in a lack of measurable brain stem potentials may not necessarily involve dysynchrony. For example, absence of an ABR in cases of axon-related neuropathies and inner hair cell lesions are also thought to be primarily related to reduced numbers of neural elements contributing to the volume-conducted response (Rance, 2005) rather than to disruptions of synchrony.

The pattern of auditory neuropathy (AN/AD) has been observed in various presentations among individuals from neonates to adults with hearing disorders. In spite of the fact that AN/AD is thought to be rather uncommon, prevalence rates of 11–15 percent have been reported by researchers in populations with hearing loss (Ngo et al., 2006). Recently, more patients with AN/AD have been reported with a wide variety of symptoms (Rapin and Gravel, 2003). However, most participants with AN/AD show variable degrees of unilateral or bilateral hearing loss, ranging from slight to profound. Low-frequency or flat audiograms are common if any degree of hearing loss exists. Nevertheless, a smaller percentage of patients display other audiometric configurations (Sininger and Oba, 2001; Rapin and Gravel, 2003; Rance et al., 2004). One of the symptoms apparent in adults with AN/AD is the absence of correlation between pure-tone threshold levels and speech-discrimination ability. This symptom plays a major role in referring a patient for detailed assessment. In most patients, speech understanding is reduced dramatically, especially in the presence of noise or in difficult hearing conditions, and is significantly poorer than would have been expected for sensorineural losses of equivalent degree (Starr et al., 1996; Zeng et al., 1999; Sininger and Oba, 2001; Starr, 2001; Rapin and Gravel, 2003; Rance et al., 2004; Rance, 2005; Zeng et al., 2005; Hall, 2007).

To date several auditory tests have been introduced to measure the threshold level at specific frequencies, especially for patients with hearing loss, but they are not commonly used due to numerous limitations and shortcomings (Stueve and O’Rourke, 2003; Gorga et al., 2004). The auditory steady-state response test, which has been introduced recently as an alternative method for obtaining pure-tone audiograms, seems to be a more promising approach because it yields frequency-specific information (Ahn et al., 2007). The ASSR is a scalp-recorded auditory evoked potential and is captured by far-field electrodes in a manner similar to that of the ABR (Plourde and Picton, 1990). A number of studies have shown that ASSR measurements can be useful in obtaining an overview of the variation in hearing threshold level with frequency and are believed to provide better hearing information even for individuals who are difficult to test or individuals with profound sensorineural hearing loss, for whom the application of other tests and methods, such as ABR, is not possible (Rance and Briggs, 2002). The exact nature of the relationship between behavioral and physiologic hearing thresholds has hitherto remained unclear, requiring further investigation (Picton et al., 2003). Moreover, there is only a very small body of information on findings of ASSR in patients with AN/AD, especially in adults with this disorder. The aim of the present study was to compare the results of auditory threshold levels obtained by conventional pure-tone audiometry with the results of ASSR measurements in adults with AN/AD.

**MATERIALS AND METHOD**

**Participants**

This study was performed on 16 adults with AN/AD (32 ears). The disorder had been previously diagnosed by means of the following criteria: (1) profound decrease of open-set word-discrimination score (WDS) in silence and in the presence of noise, (2) absent acoustic reflexes; (3) presence of otoacoustic emissions (except in one ear), (4) presence of cochlear microphonics, (5) absent ABR, and (6) normal MRI. The auditory middle latency response (AMLR) was present and normal in 8 participants, present but abnormal in 2 participants, and absent in 6 participants. The auditory late response (ALR) was present in 14 patients but could not be tested in two patients. These results are summarized in Table 1.
<table>
<thead>
<tr>
<th>Patient</th>
<th>Age/Sex</th>
<th>Pure-Tone Average R/L (dB)</th>
<th>Audiogram Shape</th>
<th>Word-Discrimination Score (WDS)</th>
<th>WDS in Noise R/L (%)</th>
<th>Otoacoustic Emissions</th>
<th>Cochlear Microphonics</th>
<th>Acoustic Reflex</th>
<th>Auditory Brain Stem Response</th>
<th>Auditory Middle Latency Response</th>
<th>Auditory Late Response</th>
<th>MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26/M</td>
<td>55/50</td>
<td>Flat</td>
<td>12/8</td>
<td>0/0</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>Normal</td>
</tr>
<tr>
<td>2</td>
<td>18/F</td>
<td>55/45</td>
<td>Inversed scoop</td>
<td>0/0</td>
<td>0/0</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>Normal</td>
</tr>
<tr>
<td>3</td>
<td>17/M</td>
<td>40/35</td>
<td>LTL</td>
<td>32/24</td>
<td>0/0</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>DNT</td>
<td>Normal</td>
</tr>
<tr>
<td>4</td>
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<td>40/40</td>
<td>LTL</td>
<td>40/16</td>
<td>8/0</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>5</td>
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<td>64/60</td>
<td>52/40</td>
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<td>Absent</td>
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<td>Absent</td>
<td>Absent</td>
<td>Normal</td>
<td>DNT</td>
</tr>
<tr>
<td>6</td>
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<td>65/55</td>
<td>LTL</td>
<td>76/72</td>
<td>12/8</td>
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<td>Normal</td>
</tr>
<tr>
<td>7</td>
<td>15/M</td>
<td>80/70</td>
<td>Flat</td>
<td>28/32</td>
<td>4/8</td>
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<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>8</td>
<td>14/F</td>
<td>55/15</td>
<td>Flat</td>
<td>32/28</td>
<td>8/8</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>Absent</td>
<td>DNT</td>
<td>Normal</td>
</tr>
<tr>
<td>9</td>
<td>28/M</td>
<td>35/35</td>
<td>LTL</td>
<td>64/52</td>
<td>48/40</td>
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<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
<td>DNT</td>
</tr>
<tr>
<td>10</td>
<td>29/M</td>
<td>70/80</td>
<td>LTL</td>
<td>60/64</td>
<td>14/8</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
<td>Normal</td>
</tr>
<tr>
<td>11</td>
<td>15/M</td>
<td>55/10</td>
<td>LTL</td>
<td>32/28</td>
<td>8/8</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
<td>Normal</td>
</tr>
<tr>
<td>12</td>
<td>25/M</td>
<td>55/50</td>
<td>Flat</td>
<td>16/12</td>
<td>4/0</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>Normal</td>
</tr>
<tr>
<td>13</td>
<td>17/M</td>
<td>40/35</td>
<td>LTL</td>
<td>32/24</td>
<td>0/0</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Abnormal</td>
<td>Normal</td>
</tr>
<tr>
<td>14</td>
<td>17/F</td>
<td>55/45</td>
<td>LTL</td>
<td>12/8</td>
<td>0/0</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>Normal</td>
</tr>
<tr>
<td>15</td>
<td>18/F</td>
<td>40/35</td>
<td>LTL</td>
<td>40/20</td>
<td>8/0</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>16</td>
<td>16/F</td>
<td>80/70</td>
<td>Flat</td>
<td>28/32</td>
<td>8/8</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
<td>Normal</td>
<td>Normal</td>
</tr>
</tbody>
</table>

Note: DNT = did not test; LTL = low tone loss.
We were able to gain a biopsy sample from the sural nerve in nine participants. The involvement of both myelin sheath and axon was observed (mixed neuropathy). Seven of these nine participants had hereditary sensory motor neuropathy, one patient had Friedrich ataxia, and one had Waardenburg syndrome.

In three participants speech-understanding ability was so poor that it led to educational and communication problems. There was no history of hearing loss, language or speech problems, or chronic or hereditary diseases in any of the families; and even several years after onset of the disease, there were no concomitant sensory or motor problems in their visual and sensorimotor evaluation or in the neurologic examination. They were suspected to have auditory neuropathy sensu stricto. In addition, four participants had idiopathic AN/AD.

Ten participants were men, and six were women. Ages ranged from 14 to 30 years (average = 21 years). The principal reason for referral of the participants for detailed assessment was that discrepancies were observed between the results of their behavioral audiometric thresholds and open-set word-discrimination scores. The mean age for the onset of the disorder was 15 years and ranged from 12 to 24 years. The WDSs of these patients in quiet were low (mean = 33.9%), which decreased drastically in the presence of noise at a +5 dB signal-to-noise ratio (mean = 3.8% [see Table 1]).

Assessments

Pure-Tone Audiometry

For behavioral audiometry, pure-tone thresholds were obtained at four octave band frequencies from 500 to 4000 Hz with a calibrated Madsen OB-822 audiometer. Pure-tone audiometric thresholds were measured with the Hughson-Westlake method (Harrell, 2002), using a 10 dB up and 5 dB down regimen.

Word-Discrimination Scores

Word-discrimination scores were obtained by means of 25-word monosyllabic Farsi word lists at appropriate suprathreshold levels. Speech audiometric stimuli were presented to each ear via TDH-39 earphones.

ASSR Test

Auditory evoked responses were recorded using a BioLogic version 2.02 system (Bio-Logic, Inc., Mundelein, Ill.). All participants were at rest, in the supine position. They were asked to relax and to close their eyes. ER-3A insert earphones were used as transducers. All electrode impedances were below 5 kΩ, and the interelectrode difference values were kept below 2 kΩ. ABR and ASSR tests were performed with closed eyes via single-channel recording, while AMLR and ALR tests were conducted in the awake state with two-channel recordings. Recording parameters for the ABR, AMLR, and ALR tests are summarized in Table 2.

The ASSR test was carried out with an upper forehead electrode and referenced to the midline posterior neck (about 7 cm below the inion). The ground electrode was attached to the right mastoid. The potentials were evoked by means of a single-modulating-frequency technique, of either 67 or 69 Hz, stimulating each ear separately at four frequencies (0.5, 1, 2, and 4 KHz). Both amplitude-modulated (AM) and frequency-modulated (FM) modes were employed at depths of 20 percent for FM and 100 percent for AM. Electroencephalographic signals were analog bandpass filtered from 10 to 300 Hz. The number of sweeps

<table>
<thead>
<tr>
<th>Test</th>
<th>Electrode Array</th>
<th>Recording Parameters</th>
<th>Stimulus Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory Brain Stem Response</td>
<td>NI: FPz</td>
<td>Time (msec)</td>
<td>Filter (Hz)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0–16</td>
<td>1000–2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Averaging</td>
<td></td>
</tr>
<tr>
<td>Auditory Middle Latency Response</td>
<td>NI: C3,C4</td>
<td>0–100</td>
<td>500–1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Averaging</td>
<td></td>
</tr>
<tr>
<td>Auditory Late Response</td>
<td>NI: Cz,Fz</td>
<td>0–500</td>
<td>250–500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Averaging</td>
<td></td>
</tr>
</tbody>
</table>

Note: NI = noninverting, I = inverting, G = ground, R = rarefaction, C = condensation.
varied with the experimental conditions so as to ensure a satisfactory signal-to-noise ratio. An F-ratio with a p value smaller than .05 was assumed meaningful for ASSR data analysis. The study was approved by the ethics board, and informed consent was obtained from all participants.

Data Analysis

SPSS 13 for Windows was used for statistical analysis. The mean behavioral auditory thresholds were compared with those of the ASSR at each frequency using the independent-sample t-test. The differences between the behavioral and the ASSR thresholds at each frequency were compared using the analysis of variance. The relationships between ASSR and PTAT measures at each frequency were analyzed by means of the Pearson product-moment correlation coefficient. A p value less than .05 was considered statistically significant.

RESULTS

Conventional Audiometric Threshold Configurations

In eight patients audiometric configuration was symmetrical and rising from low to high frequencies. In four patients the configuration was symmetrical and flat in both ears. Two patients had normal hearing in one ear and a rising contour in the other ear. Finally, two patients had a rising audiogram in one ear and trough-shaped threshold configurations in the other ear. Overall, there were two ears (6.2%) with normal hearing, 12 ears (37.5%) with mild hearing loss, 10 ears (31.2%) with moderate hearing loss, and 8 ears (25.1%) with moderate to profound hearing loss by PTAT. Twenty ears (62.5%) had low-frequency loss audiograms, 10 ears (31.2%) had flat audiograms, and two ears (6.3%) had inverted trough audiograms.

Comparing PTAT and ASSR Measurements

Table 3 summarizes the means and standard deviations of the auditory thresholds measured by PTAT and ASSR at each frequency. The average auditory thresholds estimated by ASSR were substantially poorer than the average PTAT measures (p < .001) at all four test frequencies. These average differences are graphically illustrated in Figure 1. It is noteworthy that the average difference ranges from a low of 43.1 dB at 500 Hz to a high of 77.8 dB at 4000 Hz.

Differences between PTA and ASSR Measurements

The mean/SD (range) of differences between PTA and ASSR measurements (ASSR – PTA) at each octave frequency (500–4000 Hz) are mentioned in Table 4. The result of differences between ASSR and PTA measurements (ASSR – PTA) at 500 Hz was significantly less than those of 1000 (p < 0.001, 95% CI = 9.2–38.3), 2000 (p < 0.001, 95% CI = 19.5–48.6), and 4000 Hz (p < 0.001, 95% CI = 20.1–49.2). The mean/SD (range) of total differences at all frequencies (500–4000 Hz) was 66.2 ± 17.4 dB (25–86).

Correlations between PTAT and ASSR Measurements

Figure 2 shows scatter plots of ASSR and PTAT results at each of the four test frequencies. There were no significant correlation coefficients (p > .05) at 1000, 2000, and 4000 Hz, but there was a modest coefficient at 500 Hz (r = 0.39, p = .029). In general it can be concluded that the ASSR was a poor predictor of the conventional behavioral threshold in these participants.

DISCUSSION

Audiometric Patterns

Low-frequency/rising audiometric contours were observed in more than 60 percent of this sample of adults suffering from AN/AD, while about one-third had flat audiograms. Average ASSR thresholds were much higher than those of PTAT at all frequencies (0.5, 1, 2, and 4 KHz), and the difference between ASSR and PTAT increased slightly as frequency increased.

In previous studies the audiometric patterns of patients with AN/AD low-frequency/rising audiograms were observed in approximately 30 percent of ears (Starr et al, 1996; Sininger and Oba, 2001). This can be
related to the higher level of vulnerability of long nerve axons, terminating in the low-frequency region of the cochlear apex. Based on this theory, if the pathology of auditory neuropathy is distal dendritic damage, observing a low-frequency hearing loss in the audiogram is most probable (Starr, 2001). Because the survival of the axon depends on its cell body, it seems that axonal neuropathy is caused by cell body injury. This injury can lead to the injury or death of distal dendrites, which is common in axonal neuropathy. Because of the higher susceptibility of long nerve fibers to injury, injury or death of distal processes can occur in other types of neuropathies, too. There are three types of cochlear nerve fibers with respect to their length. The longest cochlear nerve fibers go to the apex of the cochlea, the area of low frequencies. The shortest fibers go to the second half of the first turn of the cochlea, and they are responsible for the reception of middle frequencies. The fibers that go to the initial part of the basal turn of the cochlea, near the stapes, are responsible for the reception of high frequencies, with length intermediate between the previous two fiber groups. If the injury of the distal fibers leads to auditory neuropathy, then a low-frequency hearing loss will result. This type of audiogram is common in AN/AD patients (Starr et al, 2001).

Table 4. Analysis of Variance Showing the Differences between Pure-Tone Auditory Threshold (PTAT) and Auditory Steady-State Response (ASSR) Measurements

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>ASSR-PTAT (dB)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>Range 5–70, Mean ± SD 43.1 ± 16.8, P value &lt; .001</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>Range 30–90, Mean ± SD 66.9 ± 19.1</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>Range 20–100, Mean ± SD 77.2 ± 25.1</td>
<td></td>
</tr>
<tr>
<td>4000</td>
<td>Range 35–100, Mean ± SD 77.8 ± 24.7</td>
<td></td>
</tr>
</tbody>
</table>

On the other hand, mild to moderate hearing loss has been mentioned in a large number of previously published articles on auditory neuropathy prior to 1990 (Worthington and Peters, 1980; Lenhardt, 1992; Gorga et al, 1995). The tendency toward lower-frequency hearing loss may be due to a discrepancy between the results of PTAT and ABR methods used for the diagnosis of early cases of AN/AD. Recent studies have indicated that one is likely to observe variable degrees of hearing loss in patients with auditory neuropathy (Gorga et al, 1995; Rance et al, 1999; Starr et al, 2000). In the present study, the participants’ hearing thresholds ranged from normal hearing to severe hearing loss. Since the onset of AN/AD in our participants was during adolescence, and the discrepancy between the results of PTAT and WDS was the cause for their referral, a higher prevalence of this degree of hearing loss is unexpected.

ASSR

Using ASSR for an assessment of audiometric thresholds in auditory neuropathy and comparing its results with those of other routine test methods have rarely been carried out. In similar previous studies, dramatic differences have been reported between the auditory threshold results of behavioral audiometric tests and ASSR (Attias et al, 2006; Han et al, 2006), but the amount and direction of difference between the results of these tests have been variable. In agreement with the present findings, some studies have reported that PTAT results for all frequencies are better than ASSR (Han et al, 2006); whereas in other sets of studies, these results have been observed to be poorer than ASSR results for most frequencies (Attias et al, 2006).

Although previous studies have noted differences in hearing thresholds measured by behavioral and ASSR methods (Attias et al, 2006; Han et al, 2006), these differences were larger in the present study. One of the variables in this field of research is the study population and its characteristics (e.g., age of onset of symptoms). Despite the fact that various degrees of hearing loss may be observed in the behavioral audiometric test in AN/AD, moderate to profound hearing loss is usually observed in neonatal diagnosed cases, and mild to moderate hearing loss is observed in adolescents and adults. In addition, the fact that the sample size of the present study was larger than those of the two previous studies may have affected the results.

Another interesting finding of this study is that the ASSR results were not strongly related to PTAT variability at any tested frequency. Similar to our findings, in studies that have compared the results of ASSR and behavioral audiometry between various hearing-impaired patients and normal-hearing people, there was no relation reported between the results
of these tests in cases suffering from AN/AD in comparison with other groups (normal-hearing individuals and other hearing-impaired people [Attias et al, 2006]).

ASSR has been compared to conventional behavioral audiometric thresholds in different populations; in normal-hearing individuals, and in individuals with different degrees of hearing loss (Lins et al, 1996; Aoyagi et al, 1999; Attias et al, 2006; Han et al, 2006; Ahn et al, 2007). In most of these studies the researchers were interested in using ASSR as a clinical tool for the estimation of audiometric thresholds at various frequencies. In general such studies have shown that ASSR is a suitable tool for assessing

Figure 2. Scatter plots of behavioral pure-tone audiometric threshold (PTAT) and auditory steady-state response (ASSR) hearing threshold level (HTL) data at 500, 1000, 2000, and 4000 Hz.
the hearing of patients who do not fully cooperate in behavioral audimetric tests. In the case of AN/AD, however, ASSR is clearly not suitable for the estimation of audimetric thresholds because of the substantial differences between the two measures observed in the present study and the lack of correlation between the two measures. Perhaps, however, the discrepancy between the ASSR and PTAT results can be useful as an adjunct to the discrepancy between ABR and audimetric thresholds in the diagnosis of AN/AD.

It is difficult to compare various tests carried out in different studies of AN/AD because there have been significant differences in the way the tests were carried out, the characteristics and special features of the measurement equipment, and the diagnosis criteria. Standardization of a diagnostic test battery for suspected AN/AD would be a desirable goal.

CONCLUSION

The findings of the present study indicate that using ASSR with the aim of estimating the auditory thresholds of persons suspected of having AN/AD seems unsuitable. However, the discrepancy between the two measures may be a helpful adjunct to other audiological tests in the differential diagnosis of this disorder.

REFERENCES


