Presented at 111th AAO-HNSF Annual Meeting & OTO EXPO

AMERICAN ACADEMY OF OTOLARYNGOLOGY– HEAD AND NECK SURGERY FOUNDATION

Auditory Notches in 134 Band Audiograms

Automated Micro Audiometer: AMA-PTA

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American Academy of Otolaryngology-Head and Neck Surgery 2007, Vol 137, R087

111th Annual Meeting & OTO EXPO in Washington, DC from September 16~19, 2007

Abstract

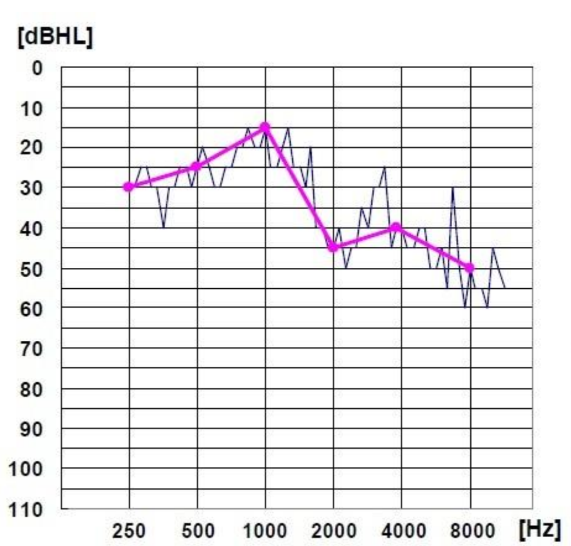
Several studies reported the prevalence of auditory notches. Auditory notches could be found in subjects with normal-hearing sensitivity as well as hearing-impaired subjects. To investigate the profile of threshold microstructure in human auditory system, frequency profiles of auditory notches were obtained from normal-hearing subjects. To identify the frequency of auditory notches, 134 band (1/24 Oct. resolution in 250~12,000 Hz) pure-tone audiometry was performed by using automated and randomized Bekesy audiometry (AMA-PTA).

AMA-PTA enabled to obtain 134 band audiogram within 35 ~ 45 minutes. The 134 band audiograms were compared with 6 band (1 Oct. resolution) audiograms. Auditory notches were observed in both ears of all subjects. However, the 6 band audiograms have missed most of the auditory notches observed in the 134 band audiograms. These auditory notches, which were not shown in conventional audiometry, were also observed in hearing-impaired subjects as well.

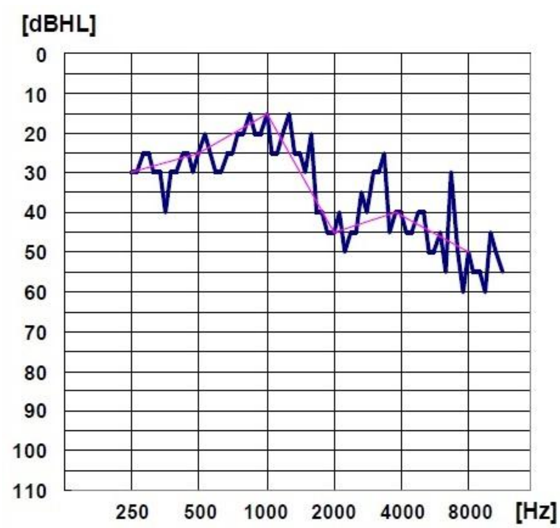
This study demonstrates that the conventional, 6 band audiometry has overlooked the microstructure of auditory thresholds.

AMA-PTA

Automated Micro Audiometer - Pure Tone Audiometry
Which is your audiogram?



Conventional Audiometry
(6 Frequencies: 20 Minutes, 11 Frequencies: 35 Minutes)



AMA-PTA
(6 Frequencies: 2 Minutes, 67 Frequencies: 20 Minutes, 134 fequencies: 40 Minutes)

Randomized and Automated Quasi Bekesy Audiometry (RAQBA)

Conventional audiometry has underestimated the effect of auditory selective attention on the threshold results. The existing presentation method ordered in frequency produces spectral cue in subject's memory. Spectral cue induces efferent inhibition (or excitation) due to auditory selective attention. This may provide inconsistent results up to 30dB in the following repeated hearing test. The best way to exclude auditory selective attention is to randomize stimulus frequency to present.

Pulsed Pure Tone

Majority of hearing loss people suffer from tinnitus. Even normal hearing person may experience a number of "inner-ear sounds" (e.g. tinnitus, SOAE, etc.) when he/she is in a sound proof room. Most of inner-ear sounds are continuous, and

1. Earlogic Corporation, 3550 Wilshire Blvd. Suite 510, Los Angeles, U.S.A.

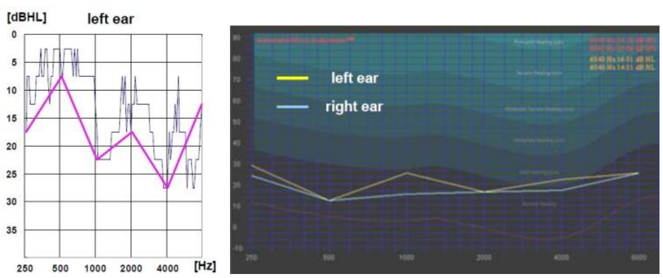
frequently confused with test tone (continuous pure tone) near the threshold levels. In this respect, pulsed pure tone would be more desirable than continuous pure tone as a stimulus.

3~4 Times Repeated Test

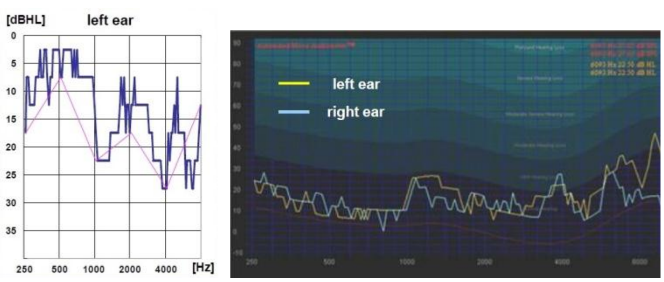
To provide more reliable threshold results, AMA-PTA executes 3~4 times repeated test in random order near the threshold levels.

Results

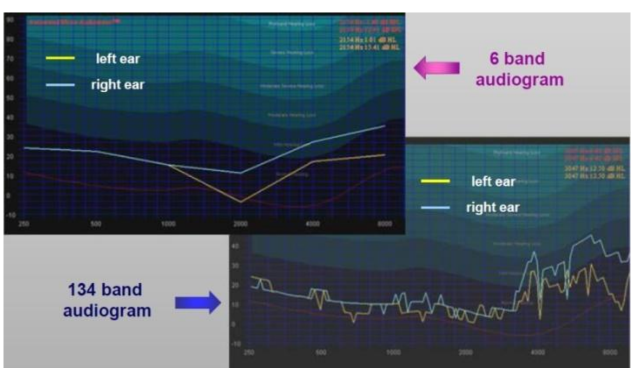
Subject A 6 band audiogram



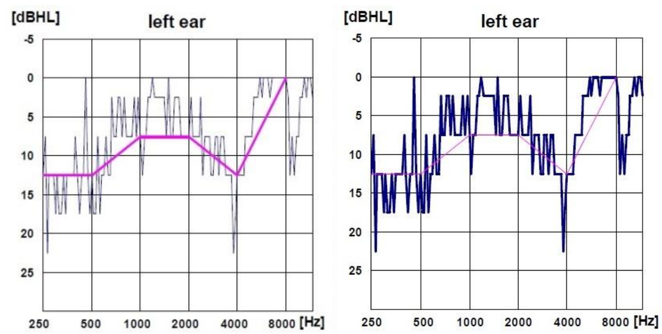
Subject A 134 band audiogram



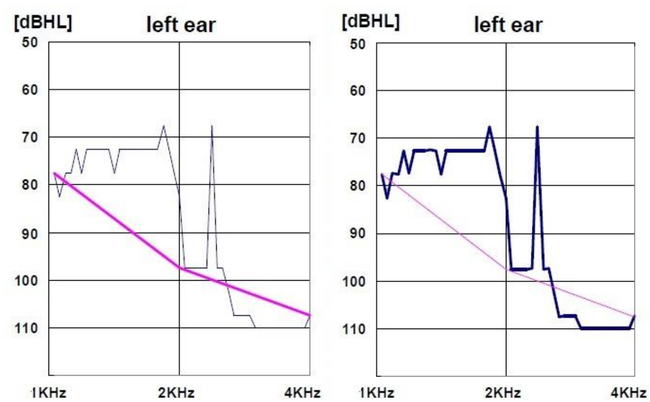
Subject B 6 & 134 band audiogram



Subject C 6 & 134 band audiogram (250~12000 Hz)



Subject D 6 & 134 band audiogram (1~4 KHz)



Conclusion

• AMA-PTA enables to obtain 134 band (1/ 24 Oct. resolution in 250 ~ 12,000 Hz) audiogram within 35 ~ 45 minutes.

• Auditory notches were observed in normal-hearing subjects as well as hearing-impaired subjects.

• Conventional, 6 band audiometry has missed most of the auditory notches observed in 134 band audiometry (AMA-PTA).

References

1. Oates P. & Stapells DR. (1997). Frequency specificity of the human auditory brainstem and middle latency responses to brief tones. I. High-pass noise masking. *J Acoust Soc Am* 102:3597-3608

2. McBride D. & Williams S. (2001). Characteristics of the audiometric notch as a clinical sign of noise exposure. *Scand Auiol* 30:106-111

3. Stapells DR. (2000). Frequency-specific evoked potential audiometry in infants. In R. C. Seewald (Ed.) A Sound Foundation Through Early Amplification. Basel: Phonak AG

Association for Research in Otolaryngology (ARO) 2010, Vol 33, p. 332, No 965

Tinnitus Spectrum and Its Realtime Visualization based on 134 band Cochlear Model

The *Abstracts of the Association for Research in Otolaryngology* is published annually and consists of abstracts presented at the Annual MidWinter Research Meeting.
[ISSN-0742-3152]

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Introduction

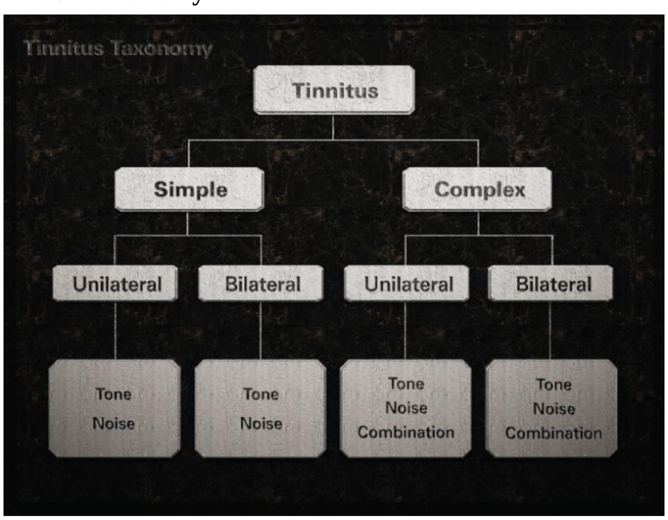
The existing method for matching tinnitus relies on the listening paradigm to a single pure tone or band pass filtered noise. There are many types of tinnitus spectrum in accordance with hearing loss regions; 1) single pure tone, 2) multiple pure tones (harmonic or non-harmonic complex tone), 3) single filtered noise, 4) multiple filtered noise, and 5) the combination of 1) ~ 4). In this respect, a new method has been designed to achieve accurate performance for finding various types of tinnitus spectrum.

This study suggests two inventions; 1) tinnitus taxonomy based on 10 types of tinnitus spectrum and 2) a method for visualization of tinnitus spectrum using 3D cochlear model with 134 bands (1/24 Oct) frequency resolution.

Methods

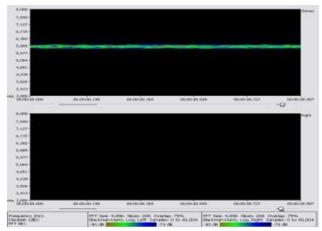
Acoustic properties of all types of tinnitus were classified in the 4 spectral categories; simple tone (pure tone), complex tone, noise, and a combination of tone and noise. Their spectra are named as follows.

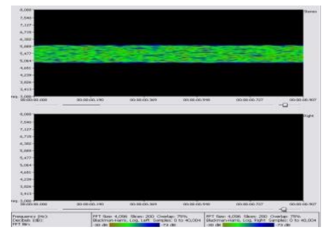
Tinnitus Taxonomy

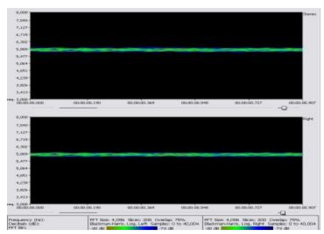


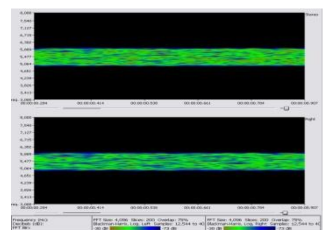
Tinnitus Spectrum

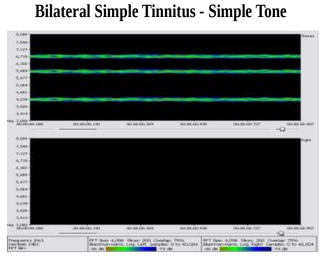
- Unilateral Simple Tinnitus - Simple Tone
- Unilateral Simple Tinnitus - Simple Noise
- Bilateral Simple Tinnitus - Simple Tone
- Bilateral Simple Tinnitus - Simple Noise
- Unilateral Complex Tinnitus - Complex Tone
- Unilateral Complex Tinnitus - Complex Noise
- Unilateral Complex Tinnitus - Tone and Noise
- Bilateral Complex Tinnitus - Complex Tone
- Bilateral Complex Tinnitus - Complex Noise
- Bilateral Complex Tinnitus - Tone and Noise

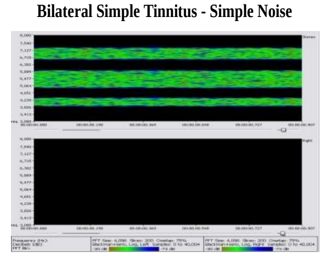

Unilateral Simple Tinnitus - Simple Tone

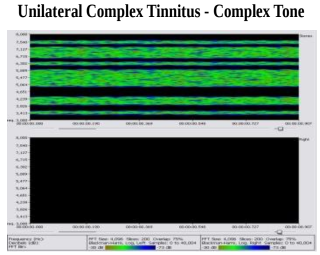

Unilateral Simple Tinnitus - Simple Noise

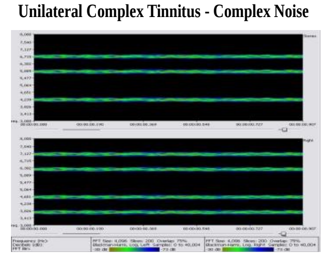

Bilateral Simple Tinnitus - Simple Tone

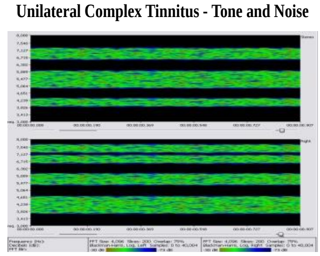

Bilateral Simple Tinnitus - Simple Noise

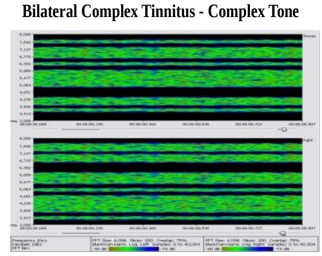

Unilateral Complex Tinnitus - Complex Tone


Unilateral Complex Tinnitus - Complex Noise


Unilateral Complex Tinnitus - Tone and Noise


Bilateral Complex Tinnitus - Complex Tone


Bilateral Complex Tinnitus - Complex Noise


Bilateral Complex Tinnitus - Tone and Noise

Results

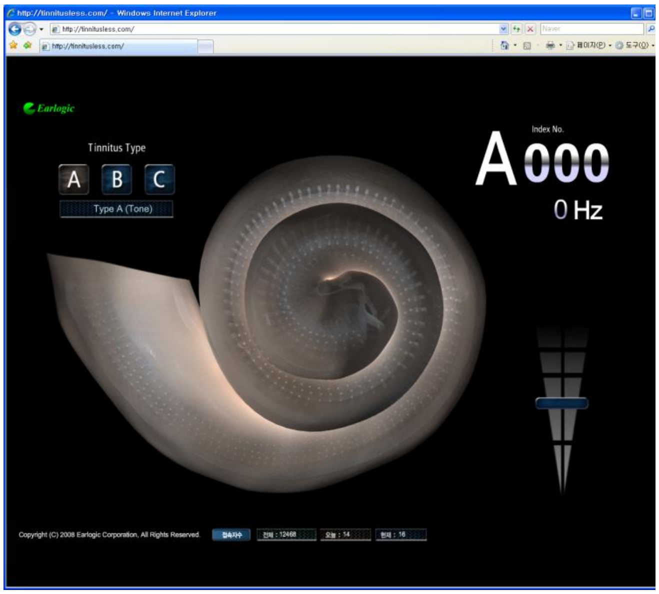
Simple Tinnitus Tester

Simple tinnitus tester was linked to the internet site, www.tinnitusless.com. Tinnitusless.com provides 402 simple tinnitus samples (134 tones, 134 noises, and 134 combinations of tone and noise).

Complex Tinnitus Tester

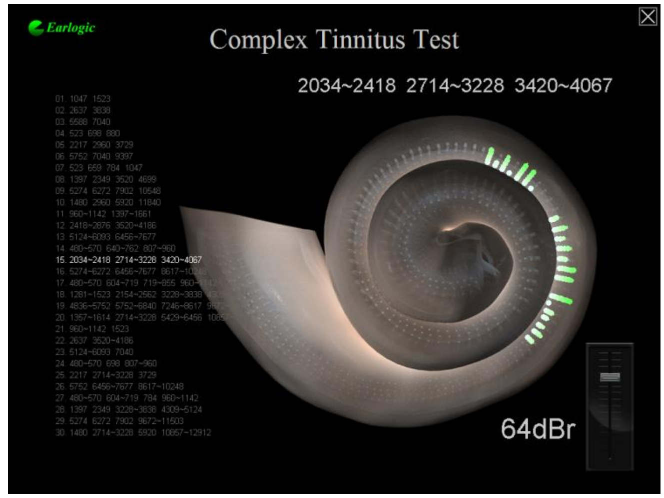
Complex tinnitus tester (Version 1.0) was designed to distribute as freeware application. It provides 30 complex tinnitus samples (10 tones, 10 noises, and 10 combinations of tone and noise).

Interface of Simple Tinnitus Tester



Simple tinnitus tester provides 3 types (A, B, C) of tinnitus sound. A is for pure tone, B is for 1 bark filtered noise, and C is for the combination of A and B. Each sample of tinnitus can be easily compared with real tinnitus of human.

Interface of Complex Tinnitus Tester



Complex tinnitus tester provides 30 different tinnitus spectra as tinnitus samples. No. 1~10 are non-harmonic complex tones, 11~20 are complex noises, and 21~30 are the combination of non-harmonic complex tones and noises.

Conclusion

3D cochlear graphic model in this study is designed based on the frequency resolution with 0.2 Bark (approx. 1/24 Oct.). It is useful for advanced tinnitus matching task with high frequency resolution. Tinnitus taxonomy proposed by this study is based on the acoustic spectrum of 10 types of physical sound.

Reference

http://www.google.com/patents/US20110263926

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[3]Earlogic Auditory Research Institute, Seoul, Korea