Wideband Immittance for Diagnosis of Hearing Loss

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Topics to be Covered

- Wideband Reflectance Principles
- Wideband Absorbance Principles
- Terminology
- Instrumentation
- Research Background
- Clinical Applications

Roots of Wideband Immittance Measures

- Wideband immittance research systems developed by Allen (1986) and Keefe, Bulen, Arehart, & Burns (1993).
- Application in clinical assessment of the middle ear has occurred in the past 2 decades.
- Frequency ranges can be accurately tested up to 8 kHz due to improved calibration and reflectance technique (Keefe et al., 1993).

Wideband Reflectance Principle

Energy Reflectance = Reflected Power Incident Power

Wideband Absorbance Principle

Absorbance = Absorbed Power Incident Power

Wideband Absorbance is Sensitive to Many Disorders

- Middle ear effusion
- Ossicular disarticulation
- Eardrum perforation
- Ossicular fixation
- Eardrum atrophy
- Tympanosclerosis
- Conductive hearing loss
- Structural ossicular abnormalities
- Superior canal dehiscence
- Increased intracranial pressure
Interacoustics Titan
Wideband Immittance

- Pressurized Measures
- Uses newly developed probe
- Acoustic Reflexes
- Pressurized TEOAE and DPOAE
- ABR with CE-Chirp

Titan Suite

The Wideband Tympanogram

Wideband Tympanometry

Wideband Tympanometry Research

Keefe & Simmons experimental system (2003)
Wideband Absorbance for Detection of Conductive Hearing Loss
Keefe et al., 2012

Effects of OME, middle ear pressure and PE tube
Sanford et al., 2014

Relation Between Pathology, ABG and Absorbance
Nakajima et al., 2013

Effects of Otosclerosis (Shahnaz & Bork, 2006)

Wideband absorbance versus admittance in newborns with abnormal DPOAE
Sanford et al. (2009), Ear and Hearing

Wideband Reflectance Normal and Abnormal Regions for Newborns
Hunter et al., 2010, Ear and Hearing
Wideband reflectance improves with age for Refer Ears

Hunter et al., 2010, Ear and Hearing

Test performance for wideband reflectance compared to 1 kHz tympanometry

Pass = 352 Refer = 141

Hunter et al., 2010, Ear and Hearing

Development of Ambient Absorbance in Normal and NICU Infants

Wideband Absorbance in Down Syndrome

34 children with DS (mean age 6.4 yrs, 63 ears):
16 normal hearing (8.65 yrs)
18 tubes (8.45 yrs)

49 TD children (mean age 5.1 yrs, 98 ears):
48 normal hearing (7.35 yrs)
30 tubes (3.60 yrs)

Ears with SNHL (2) and MHL (2) were excluded

Hunter et al., 2017, IJA

Hearing Thresholds in Down Syndrome and Typical Children

Hunter et al., 2017, IJA

Standard Tympanometry

- 226-Hz tympanometry showed normal results in 3/14 ears of TD children who had CHL, and was unable to be obtained in 6/30 ears of TD children with tubes (inability to maintain seal), while WAI was completed in all ears with tubes.

Hunter et al., 2017, IJA
Right ear of a 64 month-old male with Down syndrome and normal hearing (10-15 dB HL across frequencies) and normal DPOAE.

Left ear of a 35 month-old female with DS, who was diagnosed with OME and had elevated air conduction hearing levels.

Patient with DS and patent PE tube

• Absorbance across frequencies for diagnosis groups
• Measured at tympanic peak pressure (TPP)
• Absorbance higher in tubes for low Hz
• Absorbance lower in CHL for mid-Hz
• Correlates to behavioral hearing levels in both groups

Summary – Down Syndrome

- Normal hearing children with DS have similar absorbance across a wide range of frequencies as shown by WAI, compared to TD children.

- This finding validates WAI as a clinical tool in children with DS.

Case Examples
Wideband Test Combinations
Diagnostic Interpretation

<table>
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<th>Diagnosis</th>
<th>Air Typ</th>
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<th>OAE</th>
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Take Home Messages

- It's time to move beyond the ABCs of immittance
- Wideband tympanometry uses a familiar probe and measurement system
- The stimulus and recording is wideband
- Signal averaging and normative data are powerful techniques
- Test-retest reliability is high
- Clinical studies show better test performance than single frequency tympanometry

Ear and Hearing Supplement

Acoustic Immittance Measures
Basics and Advanced Practice

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Questions?