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Why create something new?

Hunter and Shahnaz (2013): “decision to use 226 Hz based on practicalities rather than test performance”

Terkildsen & Scott-Nielsen (1959)

220 Hz partly at random

Did not cause microphone nonlinearities, did not elicit acoustic reflexes at moderate levels

Proper calibration was only achievable with 226Hz

At 226 Hz the ear canal acts as a hard walled cavity

Compliance and Admittance have a 1:1 relationship at this frequency
But 226 Hz does the job that I want it to...
226 Hz Tympanometry: Detecting Otosclerosis

Jerger et al 1974

\[ n = 60 \]

Standard low frequency tympanometry measured

95%

Showed normal type ‘A’ tympanogram

226 Hz tympanometry is not a good test for detecting otosclerosis. Findings supported by:

226 Hz Tympanometry:

Funasaka and Kumakawa (1988)
Tympanometry in patients with Ossicular discontinuity

220 Hz only detects 42% of patients with ossicular discontinuity when using Ad tympanogram as a diagnostic classification

226 Hz is a poor predictor of middle ear effusions in babies and will be wrong in approximately 50% of cases (Lin et al 2012)

1000 Hz is better but not perfect (Baldwin 2006)
Wideband Tympanometry

Admittance

Pressure (dapa)
How does WBT work?

Changing the Stimulus

**Traditional Tympanometry**

Looks at a single probe tone frequency
At 226 Hz the middle ear is stiffness dominated
Detect problems with the TM and ear cavity (parts of the ear which affect the stiffness)

**Wideband Tympanometry**

Uses a Wideband click Stimulus
Measures the effects of middle ear pathologies at multiple frequencies
Detects problems with a high degree of accuracy
How does WBT work?
Absorbance vs Admittance

Traditional Tympanometry
Measured in admittance / Compliance
Cannot test above ≈ 1500 Hz due to effect of standing waves

Admittance (Y) = Conductance (G) + total Susceptance (jBa)

Wideband Tympanometry
Measured in Absorbance (and admittance)
Can test all the way to 8000 Hz without being contaminated by standing waves
Provides the same information as traditional tympanometry (admittance) and new information (absorbance)

Absorbance = Absorbed Power / Incident Power
The Absorbance concept

Absorbance =
- Absorbed sound
- Incident sound

OR

1 – Energy Reflectance

Table:
- Incident sound
- Reflected sound
- Absorbed sound
Introducing Wideband Tympanometry
Improved Tympanometry

Admittance tympanograms available for probe tone frequencies
226 Hz
678 Hz
800 Hz
1000 Hz

Option to break down the Y component and see the Susceptance (B) and conductance (G) components
Improved Tympanometry

At the same time the resonance frequency tympanogram is recorded. This has been reported to detect whether the ear is mass or stiffness dominated. Some clinicians use it to detect the presence of Otosclerosis and ossicular chain abnormalities.
Improved Tympanometry

A brand new tympanogram known as a Wideband averaged tympanogram can be measured.

Adults average is between 375 and 2000 Hz. In infants, its average is between 800 and 2000 Hz.

These frequencies have been optimised to detect the presence of middle ear effusions.

It is much less noise sensitive and thus produces clean tracing with noisy patients.
Understanding the Absorbance graph

The y axis shows absorbance measured by the calculation shown previously.

The red shows the absorbance characteristics for the patient.

The x axis shows frequency measured in kHz.

Age appropriate normative data

The test can be measured at peak tympanic pressure or ambient pressure.

WB Absorbance at 0 daPa
Case Studies
Case 1: Better diagnostic accuracy

1. 32 ear old woman
2. Recent pregnancy
3. Noticed hearing drop during pregnancy
4. Complains of blocked hearing
5. Ears feel blocked
6. No otalgia, tinnitus, vertigo or discharge
7. Mother has had hearing loss for 40 years+ (she is now 76)
8. Not taking any medication
Case 1: Better diagnostic accuracy

Right Ear

Left Ear

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<tr>
<th>Volume (ml)</th>
<th>Pressure (daPa)</th>
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<tbody>
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<td>Gradient (daPa)</td>
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<td>Gradient (daPa)</td>
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</table>
Wideband Tympanometry Results
Detection & Monitoring of Otosclerosis

Case 2: Better diagnostic accuracy

1. 69 Male from India
2. Complaining of dead Left ear after work accident – head trauma 15 years ago
3. Family pushing for hearing aids as hearing deteriorating
Case Study 2:

Effects of Middle-Ear Disorders on Power Reflectance Measured in Cadaveric Ear Canals

Susan E. Voss,¹ Gabrielle R. Merchant,² and Nicholas J. Horton³
Case 3: NHSP referral

1. 6 month old baby
2. Failed newborn hearing test
3. Missed follow up diagnostics appointment
4. Parents worried about Child's hearing
5. Child very distressed. Cannot settle baby to get either objective ABR or BOA
6. No head control for VRA
7. OAE’s still absent
8. Tymps obtained....
Normal or abnormal?
Case 4: More stable measurements...

(Courtesy of Jenna Quail)

2 weeks Healthy baby
Failed NHSP on L
F/u – TEOAEs present therefore pass but morphology of 1kHz compared to WBT much harder to classify trace
Case 5: Seeing through Pressure Equalization Tubes & Perforations

Example of a perforation & disarticulation of the ossicular chain

(Courtesy of Erik Hagerstrom, MD)
Many more benefits exist!