Diagnostics Testing PT I

Case History/Otoscopy
Tympanometry/Immittance Norms
Tympanometry/Immittance Instrumentation
Components of Immittance
Ear Canal Volume
Static Admittance
Tympanic Peak Pressure
Normal High Frequency Tympanogram
Resonators in the Ear
Acoustic Reflex Functions
Acoustic Reflex Pathways
Otoacoustic Emissions Advantages and Testing

Some key questions to ask:

- What brings you in today? → *General*
- Do you suspect hearing loss? Which ear? Onset → *General*
- Do you experience tinnitus/dizziness/loss of balance? → *General/Retrocochlear/SNHL*
- History of ear infections? → *General/Conductive*
- Asthma/Allergies/Cold? → *Conductive*
- History of familial hearing loss? → *SNHL/Otosclerosis*
- Pregnancy → *Otosclerosis*
- Noise exposure → *SNHL*
- Aural fullness → *Retrocochlear*
- Head trauma → *Conductive*

During otoscopy the cone of light should be at 5 o'clock position in the right ear and 7 o'clock position in the left ear with no bulging or retraction. Pathologies that can be visible during otoscopy is collapsed canals, impacted cerumen, perforation, cholesteatoma, otitis external.

Tympanometry Norms

Type	Pathology	ECV cm3	Peak Pressure daPa	Static Adm mmho
A	Normal ME Pressure	.3 – 2.5	+/- 50	.39 – 1.3
B	OM, Perf, Impacted	Varies	NP	NP
C	Early OM, ETD, Cholesteatoma	.3 – 2.5	-50 or lower	.39 or lower
As	Otosclerosis	.3 – 2.5	+/- 50	.39 or lower
Ad	OCD	.3 – 2.5	+/- 50	1.3 or higher

The instrumentation used in tympanometry includes a (1) signal/probe (speaker) that delivers a 226 Hz tone, a (2) microphone that monitors the level of the tone coming out and an (3) air pressure system that changes the pressure.

The components of immittance includes (1) admittance (Y) which is the ease that energy flows into the middle ear system, the (2) impedance (Z) is the degree to which the middle ear system rejects the flow of energy, (3) stiffness which determines how flexible the tympanic membrane is where stiffness reactance/mass susceptance is rejection by stiffness, (4) the mass where mass

reactance/stiffness susceptance is the rejection of sound by mass, and (5) resistance which is friction. The stiffness and mass are reciprocals of each other.

The ear canal volume is measured in cm3 and it is the physical volume of the ear canal. It is measured by putting in a +200 daPa and the SPL rejected sound is the ECV since all of the sound gets rejected and the variable left is the ECV. Pathologies that affect the ECV include a TM perforation or tubes which have a large abnormal ECV, cerumen impact of otitis media will read a small ECV. A value near 0 when there is nothing blocking the ear canal volume suggests that the probe is against the ear canal wall and an excessively large ECV can mean there is debris in the probe microphone.

Static admittance detects the ease of energy (Y) flowing through the middle ear from the tympanic membrane. It is also measured at 200+ daPa, a stiff system shows maximum rejection of sound and 0 daPa measurement means that the middle ear pressure is equal to the atmospheric pressure and therefore the TM is more flexible with a maximum admittance of sound through the middle ear. Some pathologies that show abnormal static admittance early otitis media or cholesteatoma which show a low static admittance, ossicular discontinuity which shows a high static admittance or otosclerosis which unclear with a 226 Hz probe.

Tympanic peak pressure determines what pressure point the tympanic membrane is the most flexible. At +200 daPa the tympanic membrane is stiff and therefore there is a low admittance of sound so there is a maximum rejection, at +100 daPa the TM is less stiff and more sound is admitted through the TM, and at 0 daPa the TM is most flexible with the highest admittance possible so that the maximum amount of sound passes through. The transmission of sound is at maximum hen the pressure in the ear canal equals the pressure in the middle ear, so if there is blockage in the middle ear the mismatch between the two pressures will block sound from entering through. Some pathologies associated with abnormal tympanic peak pressures are late otitis media with effusion which results in no tympanic peak pressure or static admittance, or a eustachian tube dysfunction which has a negative peak pressure.

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A normal high frequency tympanogram shows the following:

- ≤ 5B and ≤ 3G peaks
- daPa between G peaks < daPa between B peaks
- 3 extrema ≤ 75daPa
- 5 extrema ≤ 100daPa
- A normal tympanogram means it is a mass loaded system → ossicular discontinuity

The resonance of the middle ear is 900-1000Hz, the resonance of the ossicles is 2000 Hz (think Carhart notch), and the resonance of the ear canal is 2800-3000 Hz. The middle ear is stiffness loaded at 220 Hz (this is why we use a 226Hz probe).

The acoustic reflex involves the two smallest muscles in the human body which are located in the middle ear, the tensor tympani and the stapedius muscle. The acoustic reflex is the lowest stimulus level that causes a just noticeable difference change in the acoustic immittance of the middle ear resulting from the contraction of the stapedius muscle due to a loud intensity sound. The acoustic reflex primarily reflects the stapedial contraction of the stapedius muscle onto the neck of the stapes. The tensor tympani is mainly involved in high frequency sounds and it is inserted onto the neck of the malleus. The function of the acoustic reflex is to prevent (1) desensitization, (2) interference and (3) injury to the middle ear. During the acoustic reflex the tensor tympani contracts and pulls the manubrium inwards so that the tympanic membrane is also displaced inwards. The stapedius contraction pulls the stapes perpendicular so that the tympanic membrane does not move. The acoustic reflex is presented ipsilaterally and contralaterally using three different pure tones 500, 1000 and 2000 Hz. The stimulus elicits a reflex in both ears, but it only measured in one ear at a time, a normal hearing individual will have acoustic reflex thresholds at 70-100 dB SL.

The right ipsilateral acoustic reflex pathway begins at the right cochlea, travels through the right 8th nerve, to the right ventral cochlear nucleus (brainstem), to the right SOC (MSO, brainstem), to the right 7th nerve motor nuclei (MN), to the right 7th nerve which then in turn stimulates the right stapedius muscle. The right contralateral acoustic reflex pathway begins at the right cochlea to the right 8th nerve, to the right ventral cochlear nucleus (VCN, brainstem),

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[CROSSOVER HERE] to the left SOC (MSO) to the left 7th nerve motor nuclei, to the left 7th nerve, to the left stapedius muscle.

Otoacoustic emissions determine pre-neural outer hair cell function and are not affected by retrocochlear pathologies. The advantages of testing OAEs is that they are highly sensitive and site specific to OHC function, they do not require behavioral cooperation or response, they are highly frequency specific and can be quick. OAE testing is inexpensive and can be done with portable devices for testing children and those who are disabled. Transient evoked otoacoustic emissions (TEOAEs) are elicited by an 80dB click sound, they are present in more than 99% of people with normal hearing and 30% of people with mild hearing loss – TEOAEs are affected by any conductive pathology. TEOAEs tested must have a reproducibility and stability of above 75% and frequency bands of at least 2,3, and 4 kHz with a response of 6dB above noise floor to be considered normal. Distortion product otoacoustic emissions (DPOAEs) are elicited by two different frequency tones (2F1-F2) that cause a distortion product and are performed if an individual fails TEOAEs. In order for DPOAEs to be considered normal there must be a 6dB greater than noise. DPOAEs are absent in patients with SNHL greater than 50dB and are affected by a conductive hearing loss.