Challenging Hearing Aid Fittings

A Case-Based Approach to Acoustic Coupling

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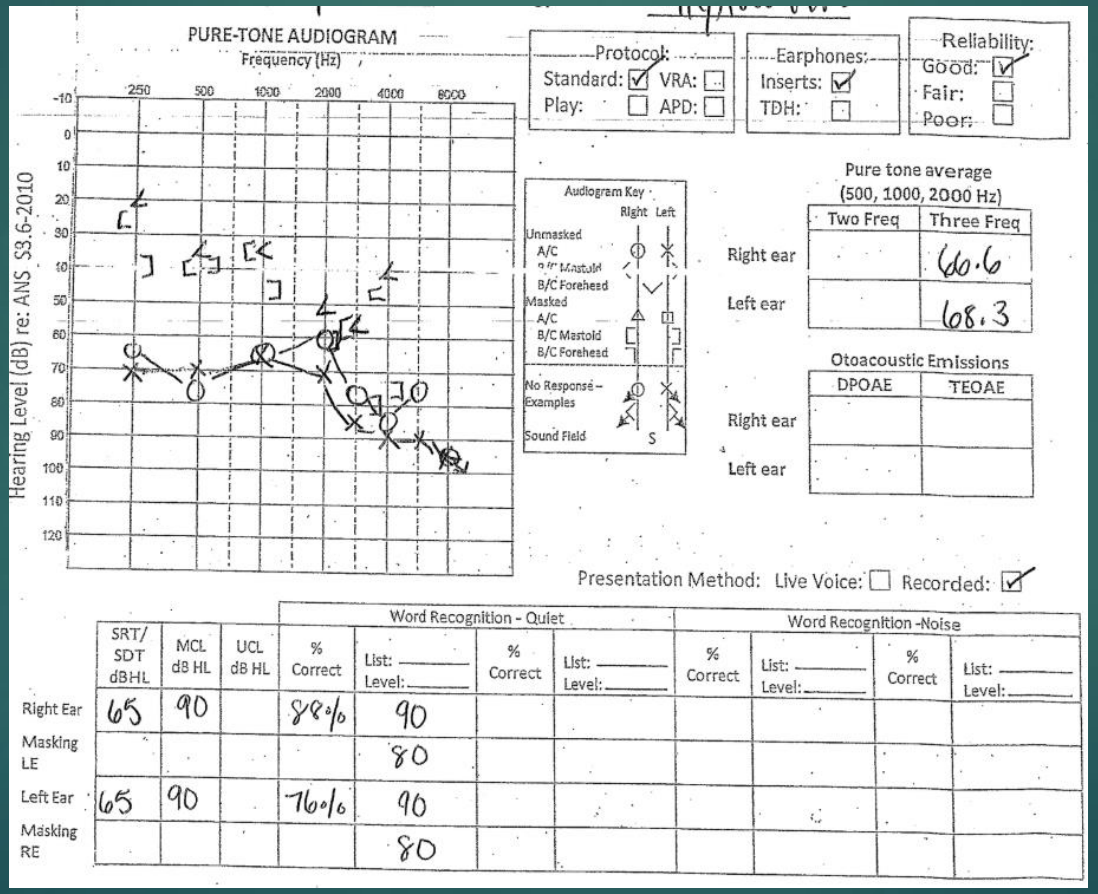
Case History

- Pt is a 74 y/o male with presbycusis
- Reported occasional “tonal” tinnitus
- Denies vertigo and imbalance
- History of bilateral tympanic membrane perforations since childhood (does not recall origin)
- Laser-assisted tympanoplasty surgery was unsuccessful
- Reports occasional otorrhea
- Under regular care of otolaryngologist

Audiogram on 4/29/2025



PURE-TONE AUDIOGRAM

Frequency (Hz)

250 500 1000 2000 4000 8000

Hearing Level (dB) re: ANS S3.6-2010

-10 0 10 20 30 40 50 60 70 80 90 100 110 120

Protocol: Standard: ☑ VRA: ☐ Play: ☐ APD: ☐

Earphones: Inserts: ☑ TDH: ☐

Reliability: Good: ☑ Fair: ☐ Poor: ☐

Audiogram Key

Right Left

Unmasked
A/C
B/C Mastoid
B/C Forehead

Masked
A/C
B/C Mastoid
B/C Forehead

No Response – Examples

Sound Field S

Pure tone average (500, 1000, 2000 Hz)

	Two Freq	Three Freq
Right ear		60.6
Left ear		68.3

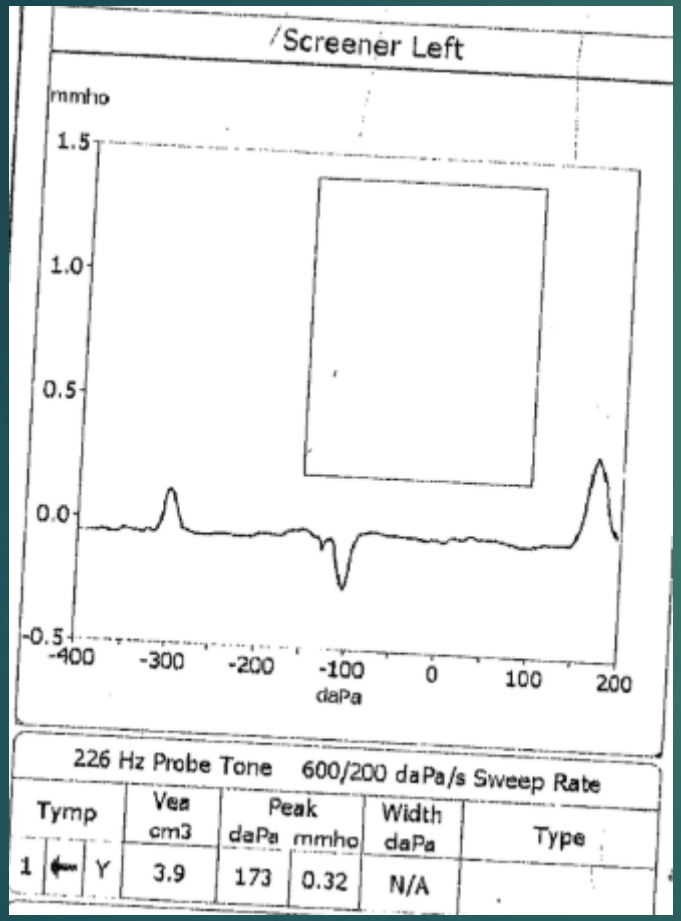
Otoacoustic Emissions

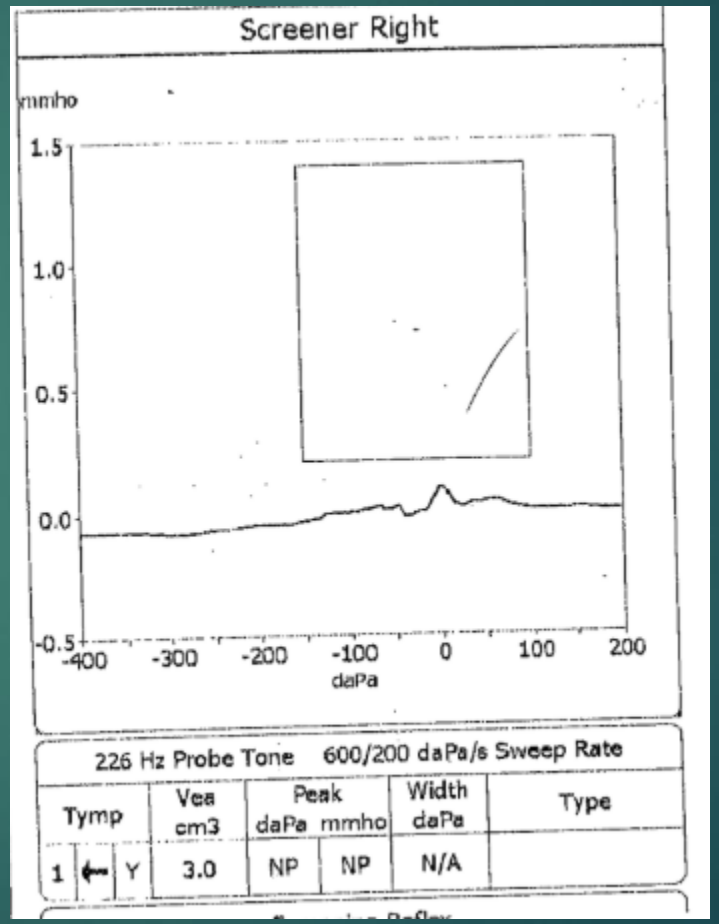
	DPOAE	TEOAE
Right ear		
Left ear		

Presentation Method: Live Voice: ☐ Recorded: ☑

	SRT/ SDT dB HL	MCL dB HL	UCL dB HL	Word Recognition - Quiet: % Correct	List: Level:	% Correct	List: Level:	Word Recognition -Noise: % Correct	List: Level:	% Correct	List: Level:
Right Ear	65	90		88%	90						
Masking LE					80						
Left Ear	65	90		76%	90						
Masking RE					80						

Tympanometry





Hearing Aid History

- Long term hearing aid user
- Dispensed with binaural Phonak (Receiver-In-The-Canal) RICs purchased in 2020 and noted the earmolds are too tight.
- For about one year, he perceived occlusion with his own voice when the devices are inserted deeply, leading him to wear them more superficially.

Hearing Aid Dispense on 7/21/2025

- Fit with binaural Phonak Audeo I90-Sphere RICs with power receiver and with acrylic c-shells.
- C-shells had AOV (acoustically optimized venting) with a small vent.
- Initially speech mapped to NAL-NL2 targets according to his audiogram with original audiogram but patient reported it was intolerable and too loud.
- Re-speechmapped without bone conduction to decrease gain.
- High compression ratios (over 2.5) were noted overall.
- Targets could not be matched within 5 decibels over 4000 Hz and sound recover (Phonak proprietary frequency transposition/frequency compression) was turned on to reach targets.
- Patient noted occlusion with is own and LFs were lowered.
- Patient was satisfied with loudness and sound quality overall.

First Follow Up 8/6/2025

- Patient reported
  - His own voice was too loud, background noise was too loud and overall HAs were “too boomy.”

- Soft noise reduction (expansion) was increased to maximum
- Decreased Ultrazoom to Fixed Zoom in Speech in Noise in Autosense OS to give patient more directionality.
- Patient noted that his own voice was better but still concerned it will be too loud when he leaves the office.
- Made a follow up appointment in 2 weeks to address concerns if needed.

Second Follow Up 9/2/2025

- Pt noted :
  - People speaking very close to him sound very far away.
  - Clarity is significantly diminished when people are speaking.
  - Overall the hearing aid output is “unnatural and weird”. He stated “ People’s voices sound like a speaker on a radio.”
- Own voice is “still too loud and boomy.”

Second Follow Up 9/2/2025

- Assessment of programming in the software could not account for these issues.
- Assessed the acoustic coupling of the c-shell.
  - C-shell appeared to fit well
- Due to reports significant occlusion sent in the c-shell for a complete remake.
  - Two sets of earmold impression were done include closed jaw and bite block.
- Requested Phonak laboratory to make a longer canal that is tapered with medium vent to address occlusion.

Third Follow up 9/22/25

- Patient fit with new c-shells.
- Speechmapped to NAL-NL2 targets, increased MPO and decreased CRs overall
- Patient noted significant improvement in overall sound quality and c-shells were significantly more comfortable.
- He noted “slight” occlusion with his own voice but significantly better than before.

Fourth Follow Up 10/2/2025

- Patient returned and stated he was very satisfied with the hearing aids, was hearing significantly better than his previous fits and overall receiving excellent benefit from the devices

The Outcome

- What was happening?
- The sound bore direction of the c-shell in the initial fitting was drilled in the direction where it was hitting his canal wall.
- The remade c-shell had the sound bore drilled in a different direction to funnel sound directly into the canal.
  - Redirection improved sound delivery through the canal pathway.
- The shell tip was drilled longer to decrease occlusion.

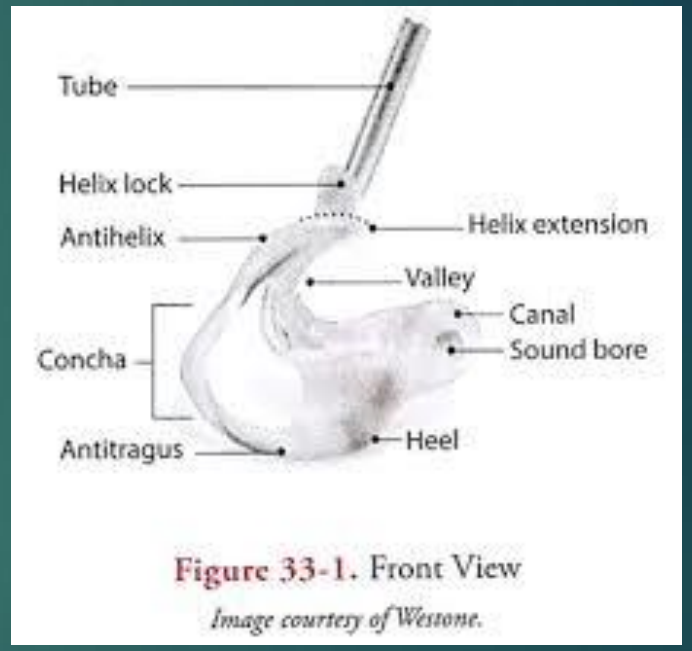


Figure 33-1. Front View

Image courtesy of Westone.

Earmold Considerations

- When there's nothing you can do in the software → check the acoustic coupling.
- " A hearing aid is only as good as it's insertion."

Earmolds and Ear Canal Acoustics

- The fitting of the earmolds affects the sound path of output of the hearing aid.
- Modern hearing aids incorporate advanced AI-driven algorithms, expanded input dynamic range, and broader bandwidth to optimize sound processing.

BUT

- Technology cannot compensate for poor fit!

Earmold Challenges

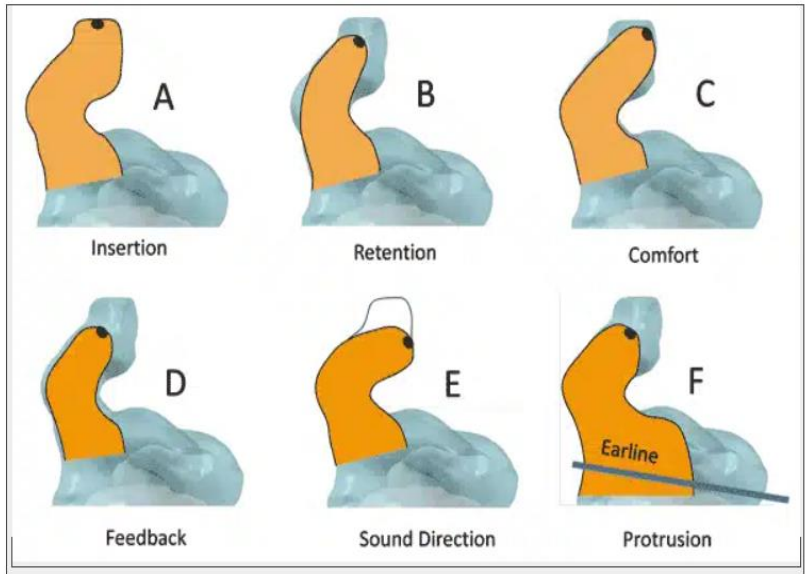


FIGURE 2. Common challenges in earmold fittings.

The virtual modeling has several objectives, which include:

1) Easy earmold insertion into the ear;
2) Secure fit (adequate retention);
3) Comfort;
4) Sufficient acoustic seal to prevent the occurrence of acoustic feedback;
5) Correct sound direction inside the ear canal; and
6) Discreet, cosmetically appealing fit in the ear.

Pirzanski, 2010

Earmolds and RICs

- It's very important to take the patients individual ear canal anatomy into account when doing a custom mold with a RIC.
- Since receivers are not malleable, its important to examine the earmold to make sure the earmold does not hit a canal wall. This can often happen with an ear with a sharp bend as you enter the aperture or steeply sloping canals towards the tympanic membrane. (West, 2010)
- During fittings it is important to examine that the direction of the sound bore where the receiver fits in to make sure it goes directly into the patient's canal. (West, 2010).

What to consider when looking at EM fittings:

- There is a variability of patient ear canal anatomy at all age groups. (Voss et al., 2025)
  - Where are their bends?
  - Where are the curvatures of the canal?
  - What is level of collapse of the canal?

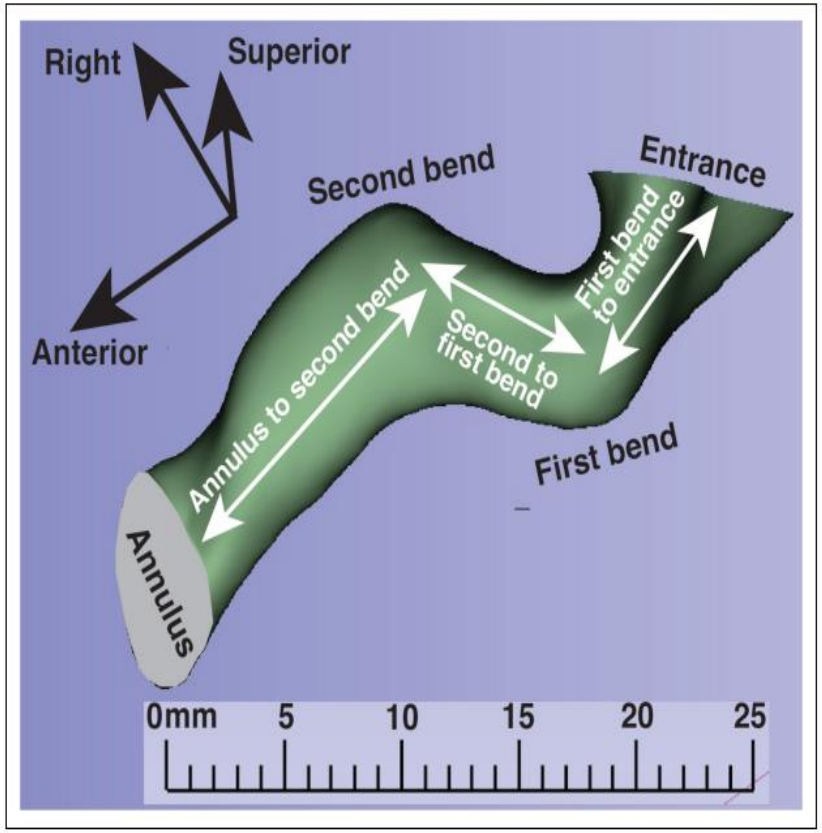


Figure 1. Schematic diagram representation of the adult ear canal shape, derived from the airspace extracted from a 3D CT scan (left ear, subject 15,154, female, 43.2 years) using the open-source software platform 3D slicer. The diagram highlights the key anatomical features of the annulus, the second bend, the first bend, and the entrance. White lines with double arrows indicate the distances corresponding to measurements reported in this study. Orthogonal vectors drawn with black lines define the directions of superior, anterior, and right, where right indicates toward the right side of the head and is a result of how the canal is oriented in 3D space. Note that the airspace is visualized as a 2D projection of the 3D canal structure, and curves out of the chosen plane are less or not discernible in this representation. 3D CT = three-dimensional computed tomography; 2D = two dimensional.

Contraindications

Not fitting the earmolds to patient's anatomy can lead to:

- Difficulty positioning the sound bore where it's supposed to go
- Poor sealing and retention (instability in canal
- Physical discomfort
- And many other things!

Hearing Review, 2009; Pirzanski, 2001

Earmold Considerations

- Sound bore
  - Diameter and placement of the sound bore affect the frequency response of the output, and subjective perception of occlusion (Taylor and Teter, 2009)
  - Look at the direction sound bore-where is it going
    - If bore points towards canal-you have sound reflection and attenuation
    - How long is the sound bore- what is it's length relative to the canal?
  - Sound bore seal location where pressure boundary forms is defined as the termination point of the sound bore (Denk et al., 2023)
    - If sealing point is too lateral/shallow →
      - Larger area of cartilaginous portion of canal exposed leading to presence of higher LF levels and higher subjective occlusion effect.
      - If sealing point is too medial/deep → different resonant behavior

Other considerations:

- Venting
  - Vent is close to sound bore
  - How much leakage/feedback are you trading off to control for occlusion?
- Earmold material
- Earmold style
- Tubing and horn (for BTEs)
- Recommended reading: Killion, M. C. (2003). Earmold acoustics. Seminars in Hearing, 24(4), 299–311.

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