VALIDATION OF THE AUDIOSCAN VERIFIT2 PROBE TUBE PLACEMENT TOOL

Western National Centre for Audiology

Paula Folkeard, AuD[1] , John Pumford, AuD[2], Jonathan Pietrobon, MESc[2] , Susan Scollie, PhD[1]
[1]National Centre for Audiology, Western University, London (ON) Canada, [2]Audioscan, Dorchester (ON) Canada

audioscan® Professional Verification

Rationale

Although routine verification of hearing aid responses using real ear measures (REM) is a part of recommended practice [1, 2], this verification technique is frequently not performed by clinicians [3, 4]. This lack of use is attributed by some to the perceived complexity of the REM process [3]. The probe tube used in REM must be placed within 5mm of the eardrum to obtain accurate measurements, particularly in the high frequencies [5, 6, 7]; however, contact with the tympanic membrane (TM), which can cause discomfort, must be avoided. To aid in probe tube placement, Audioscan has developed a probe tube placement tool, referred to as the Probe Tube Guide (PTG). The PTG is an automated, software-driven feature that uses a machine-learning algorithm which considers the location of standing waves in the ear canal relative to a previously measured acoustic data set to predict the location of the end of the probe tube relative to the TM [8]. In this poster, we will describe the performance of the PTG as integrated in the Verifit2 with adults with normal middle ear status and normal external ear canal status.

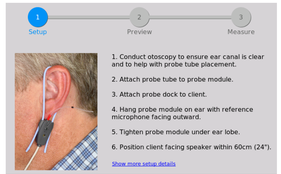
Materials and Methods

The accuracy and test-retest reliability of both probe tube placement and REM was assessed in two conditions: (1) a probe tube placed by an experienced clinician using a clinically typical visually-assisted (VA) positioning method with otoscopy; and (2) a probe tube placed using the PTG. Twenty participants (10 males and 10 females ages 25-81) who presented with normal middle ear and external ear canal status completed the protocol.

Probe tube placement was completed on the forty (40) adult ears, twice using the VA positioning method, and twice using the Audioscan PTG method. The starting order was counterbalanced across ear and across condition. A within-subjects design was used to measure these system performance variables at the individual level using comparisons of Real Ear Unaided Responses (REUR) and probe tube depths across participants and methods. Expert clinician confirmation of acceptability of placement of PTG using otoscopy and patient reports of tympanic membrane contact were recorded.

Procedure

1. Initial Otoscopy.
2. Setup Verifit2 for probe tube placement.
3. Start with the probe tube outside of the ear.



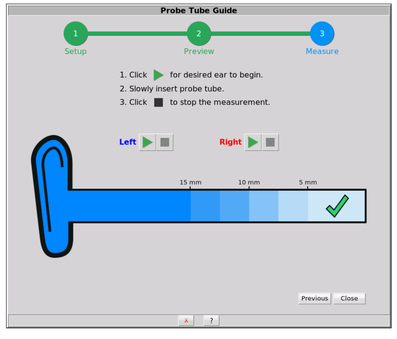
Probe Tube Guide Protocol (PTG)

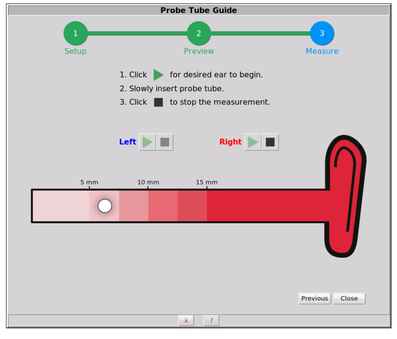
4. Start Probe Tube Placement Tool using PTG icon on SpeechMap screen.
5. Select ear on PTG Screen and press ▶
6. Insert probe tube into selected ear canal until ✓ appears on-screen and there is an audible "Chime".
7. Run REUR.
8. Mark probe tube at inter-tragal notch.
9. Remove from ear and measure from mark to end of probe tube to determine insertion depth.
10. Repeat protocol for test-retest.

Visually-Assisted Protocol (VA)

4. Insert probe tube into ear canal to within 5mm of tympanic membrane using otoscopy.
5. Run REUR.
6. Mark probe tube at inter-tragal notch.
7. Remove from ear and measure from mark to end of probe tube to determine insertion depth.
8. Repeat protocol for test-retest.

Probe Tube Guide (PTG): Clinical Interface





Results

1. Real Ear Unaided Response (REUR) Comparison

All statistics were completed using SPSS v24. A repeated measures analysis of variance (ANOVA) was completed with *frequency* as the within-subject factor and *method* and *ear* as between-subject variables. Eight tests were compared: Visually-assisted (VA) and Probe Tube Guide (PTG) x 2 ears x 2 runs each.

As expected, results (Fig 1.1) indicated that ***Frequency*** was significant: F(6.44, 978.98)=965.71, p<.001, η^2=.86. ***Ear tested*** was not significant F(1, 152)=2.01, p>.05). ***Test Method*** (i.e. VA1 vs. VA2 vs. PTG1 vs. PTG2) was also not significant F (3, 152)=.090, p>.05) indicating good test-retest reliability within the test methods and a lack of differences between test methods.

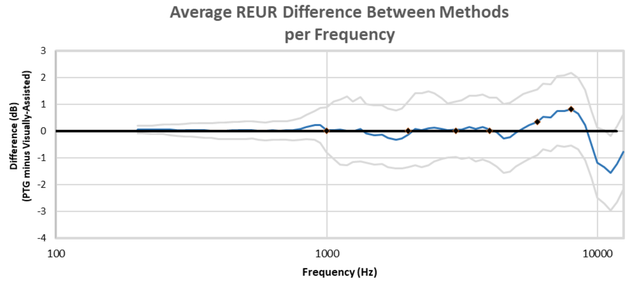
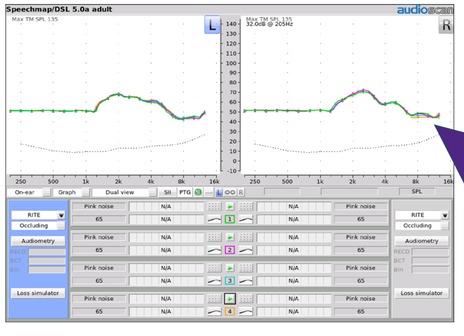


Figure 1.1. Average real-ear unaided response (REUR) differences across frequencies with a 65 dB SPL pink noise input signal with 95% confidence intervals (PTG minus VA). Audiometric frequencies of 1000-8000 Hz marked◆ for reference.



REUR Case Example

Test 1: VA Initial
Test 2: VA Retest
Test 3: PTG Initial
Test 4: PTG Retest

2. Probe Tube Depth Comparison

Probe tube placement depths (Fig 2.1) ranged from: 29-41 mm (x=33.80 mm) for males and 25-35 mm (x=30.11 mm) for females. Probe tube depth per gender was significantly different, F(1, 38)=20.03, p<.001, η^2=.345.

When the probe tube depth of the 40 ears (20 left and 20 right) were compared across the four test methods (VA1, VA2, PTG1, PTG2), the ANOVA results indicated ***Test Method*** was not significant F(2.47, 93.73)=.773, p=>.05, nor was ***Method by Gender*** F(2.47, 93.73)=.669, p>.05.

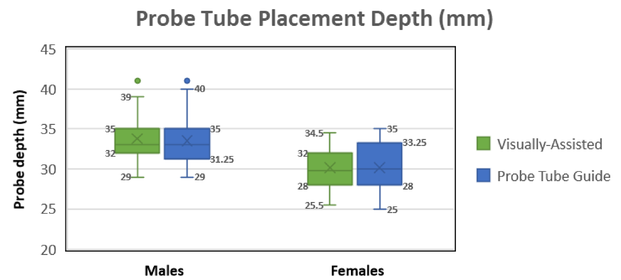


Figure 2.1. Probe Tube Placement depth (mm) relative to the inter-tragal notch for 20 male and 20 female ears (10 participants per gender group x 2 ears). Each box represents the probe tube depth mean (x), median (-), measurement range (I), first quartile (bottom of box), third quartile (top of box) and outliers (*).

REUR: Pairwise Comparisons of Method by Frequency

Although there was no significant overall effect of test method nor a significant effect of test method by frequency F(19.32, 978.98)=.345, p>.05), because probe tube placement effects are more sensitive at some frequencies compared to others, pairwise comparisons for each of the 73 frequencies were examined across the tests (VA1, VA2, PTG1, PTG2). Results confirmed that there were no significant differences at any frequency between any of the methods indicating good test-retest reliability within each test method and good matches between the two methods at all frequencies.

Summary

In the cases that were evaluated using the recommended protocol, the Verifit2 Probe Tube Guide (PTG) provided a probe tube placement depth and resulting REUR measure that was not significantly different than those obtained by an experienced clinician using traditional probe tube placement methods. Test-retest reliability was good for both visually-assisted (VA) and PTG methods. The PTG resulted in acceptable probe tube placements as assessed by an experienced clinician using otoscopy for all participants. There was no reported contact with the tympanic membrane for either method. Further evaluation is required to assess the tool with other clinical populations, such as infants, children, and those with atypical external and middle ears.

References

[1] AAA. (2006*). Guidelines for the Audiological Management of Adult Hearing Impairment*. Audiology Today, 18(5). Retrieved from https://audiology-web.s3.amazonaws.com/migrated/haguidelines.pdf_53994876e92e42.70908344.pdf
[2] CASLPO. (2016). *Practice Standards for the Provision of Hearing Aid Services by Audiologists*. Retrieved from http://www.caslpo.com/sites/default/uploads/files/PS_EN_Practice_Standards_for_the_Provision_of_Hearing_Aid_Services_By_Audiologists.pdf
[3] Mueller, H.G. (2014). *20Q: Real-ear probe-microphone measures - 30 years of progress?* AudiologyOnline, Article 12410. Retrieved from http://www.audiologyonline.com
[4] Mueller, H.G. & Picou, E.M. (2010). *Use of real-ear probe-microphone measures*. The Hearing Journal, 63(5), 27-32.
[5] Bagatto, M., Seewald, R.C., Scollie, S., & Tharpe, A. M. (2006). *Evaluation of probe-tube insertion technique for measuring the real-ear-to-coupler difference (RECD) in young infants.* J.Am Acad Audiol, 17(8), 573-81
[6] Vaisberg, J., Macpherson, E., & Scollie, S. (2016). *Extended bandwidth real-ear measurement accuracy and repeatability to 10kHz*. IJA 55(10). Retrieved from https://doi.org/10.1080/14992027.2016.1197427.
[7] Moodie, S., Pietrobon, J., Rall, E., Lindley, G., Eiten L., Gordey, D., Davidson, L., Moodie, K.S., Bagatto, M., Magathan Haluschak, M., Folkeard, P., & Scollie, S. (2016). *Using the real-ear-to-coupler difference within the American Academy of Audiology pediatric guideline: protocols for applying and predicting earmold RECDs*. J.Am Acad Audiol, 27(3), 264-75.
[8] Pietrobon, J., Pumford, J., Folkeard, P., & McInerney, C. (2018). *Application of real time recurrent neural networks for estimating probe tube insertion depth*. Poster Presentation – IHCON, Lake Tahoe, NV.