Validity of the Hum Test, a Simple and Reliable Alternative to the Weber Test

Omar H. Ahmed, MD[1]; Ryan Ruiz, MD[1], William H. Shapiro, AuD[2], Catherine Flynn, AuD[1], Binhuan Wang, PhD[3], Erich P. Voigt, MD[1]

[1]Department of Otolaryngology-Head and Neck Surgery, New York University Langone Medical Center, [2]Cochlear Implant Center, New York University Langone Medical Center, [3]Department of Population Health, Division of Biostatistics, New York University

ABSTRACT

Background: The Hum Test is a simple alternative to the Weber Test that detects presence and type of hearing loss in patients with hearing change who previously had normal hearing. The advantages of the Hum Test are that it can be administered remotely (i.e. over the phone) and without equipment.

Objectives: To compare the sensitivity, specificity, and accuracy of the Hum Test and Weber Test using pure tone audiometry [PTA] as the “gold standard.”

Study Design: Prospective, cross-sectional study.

Methods: 29 participants with normal hearing of ages 18-35, and without any history of chronic hearing problems or otologic conditions were enrolled. Subjects underwent three tests (Hum Test, Weber Test, and PTA) across two conditions: with an ear plug in one ear (randomized) and without ear plugs.

Results: When examining the ability of the Hum Test to detect simulated conductive hearing loss (CHL), the test had a sensitivity of 89.7% and specificity of 100% with high pitch humming, and 93.1% and 100%, respectively, with low pitch humming. The Weber Test had a sensitivity and specificity of 96.6% and 100%, respectively. McNemar’s test demonstrated agreement between the Hum Test, performed with either high pitch (p=0.32) or low pitch (p=0.56) humming, and the Weber Test.

Conclusions: In normal hearing patients with a new onset CHL, the Hum Test had high diagnostic sensitivity and specificity relative to PTA, as well as good agreement with the Weber test.

CONTACT

Omar H. Ahmed, MD
NYU Langone Medical Center
Email:
Omar.Ahmed@nyumc.org

INTRODUCTION

The Hum Test is used by Otolaryngologists as an alternative to the Weber Test to detect presence and type of hearing change, however its use has not yet been formally validated. The test is thought to work similarly to the Weber Test in its ability to detect conductive hearing loss (CHL). The advantages of the Hum Test are that it can be administered remotely (over the telephone) and without equipment.

To compare the diagnostic performance of the Hum Test to the more established Weber test using pure tone audiometry (PTA) as the definitive comparator, we designed a prospective study where each subject underwent all three tests with normal hearing and with simulated CHL.

METHODS

Study subjects were recruited from the NYU School of Medicine, Department of Otolaryngology- Head and Neck Surgery, and the surrounding community. Participants were prospectively enrolled to evaluate the performance of the Hum Test compared to the Weber Test using PTA as the “gold standard.” Participants had to meet the following criteria: 18-35 years of age, no history of chronic hearing or otologic problems, no history of ear surgery (except tympanostomy tube placement), and no current hearing abnormalities or recent upper respiratory infection (<1 month).

Institutional Review Board (IRB) approval was obtained prior to study commencement. Informed consent was obtained for each subject

The study session was divided into four parts: 1) participants filled out a brief questionnaire eliciting their age, gender, and any current or previous history of hearing or otologic problems, 2) Otoscopic examination of each participant was performed to detect any abnormality that may significantly impact hearing (partial cerumen impaction and myringoscleorsis were permissible), 3) Subjects underwent three tests (Hum Test with high and low pitch humming, Weber test, and PTA) with an ear plug in one ear (randomized by coin flip) and without any ear plugs. 3M E-A-R Classic Ear Plugs were used, simulating a CHL of about 25-40 dB across 250Hz-4kHz.[1]

The Hum Test was administered by asking subjects to first hum at a high pitch for a few seconds. The subject was then asked if the sound was more pronounced on the left or right, or if the sound was perceived equally. This was then repeated in a low pitch. The Weber test was administered by gently striking the elbow with the tine of a 512 Hz aluminum tuning fork and then placing the base of the tuning fork onto the subject’s forehead while asking if the sound appeared to be lateralizing. A 512 Hz tuning fork was used rather than a 256 Hz as it associated with less false-positives.[2] PTA was performed using a standard clinical audiometer in a soundproofed room. PTA measurements included air conduction (AC) thresholds from 500Hz to 4kHz .

The data for each test was collected and adapted to the format presented in **Table 1**. Values for sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were then generated for each test.

RESULTS

A total of 29 participants completed the study. There were 15 males and the average age was 26.5 (SD±2.9). All participants did not have current or prior history of hearing problems and were found to have a normal otoscopic examination. PTA confirmed normal AC thresholds bilaterally in all subjects. PTA confirmed simulated CHL in all subjects (defined as ≥10 dB AC threshold decrease[3]).

Using PTA as the “gold standard,” diagnostic performance data for the Hum Test and Weber Test were determined (**Table 2a-c)**. For the Hum Test performed with high pitch humming, the sensitivity and specificity were 89.7% and 100%, respectively. For the Hum Test performed with low pitch humming, the sensitivity and specificity were 93.1% and 100%, respectively. For the Weber test, the sensitivity and specificity were 96.6% and 100%, respectively. Exact Nemar’s test determined there was no statistical difference in sensitivity between the Hum Test-high pitch and the Weber Test (p=0.32) as well as between the Hum Test-low pitch and the Weber Test (p=0.56). **Table 3** gives a graphical representation of the sensitivities and specificities of all tests.

	Disease (+)	Disease (−)	Measures
Positive test (+)	True positives (TP)	False positives (FP)	Positive predictive value (PPV) = $\frac{TP}{TP + FP}$
Negative test (−)	False negatives (FN)	True negatives (TN)	Negative predictive value (NPV) = $\frac{TN}{FN + TN}$
Measures	Sensitivity $\frac{TP}{TP + FN}$	Specificity $\frac{TN}{FP + TN}$	Accuracy $\frac{TP + TN}{TP + FP + FN + TN}$

Table 1. Formulae used to calculate diagnostic test performance. Disease status determined by PTA “gold standard.”

Hum Test High Pitch	CHL (+)	CHL (−)	Measures
Abnormal (+)	26	0	PPV 100%
Normal (−)	3	29	NPV 90.6%
Measures	Sensitivity 89.7%	Specificity 100%	Accuracy 94.8%

Table 2a. Data for the Hum Test performed with high pitch humming. Normal(−): no lateralization. Abnormal(+): lateralization to plugged ear. No subjects lateralized to ear opposite of plug.

Hum Test Low Pitch	CHL (+)	CHL (−)	Measures
Abnormal (+)	27	0	PPV 100%
Normal (−)	2	29	NPV 93.5%
Measures	Sensitivity 93.1%	Specificity 100%	Accuracy 96.6%

Table 2b. Data for the Hum Test performed with low pitch humming. Normal(−): no lateralization. Abnormal(+): lateralization to plugged ear. No subjects lateralized to ear opposite of plug.

Weber Test	CHL (+)	CHL (−)	Measures
Abnormal (+)	28	0	PPV 100%
Normal (−)	1	29	NPV 96.7%
Measures	Sensitivity 96.6%	Specificity 100%	Accuracy 98.3%

Table 2c. Data for the Weber Test. Normal(−): no lateralization. Abnormal(+): lateralization to plugged ear. No subjects lateralized to ear opposite of plug.

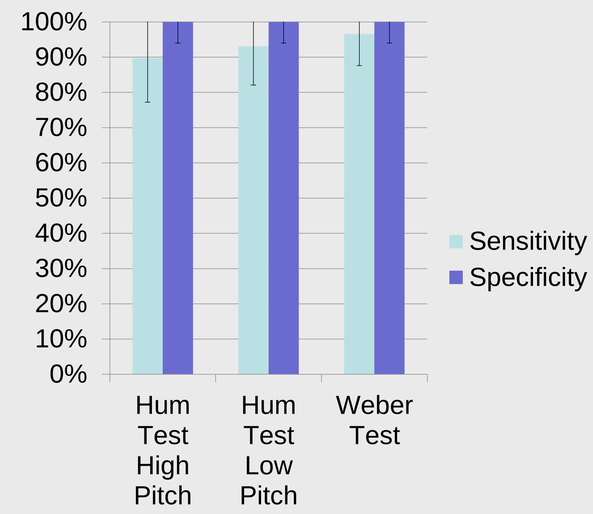

Table 3. Sensitivities and specificities of all tests with error bars (95% confidence intervals).

CONCLUSIONS

This study evaluates the diagnostic performance of the Hum Test compared to the Weber Test in its ability to detect unilateral conductive hearing loss (simulated by ear plug attenuation of ~25-40dB) in subjects with previously normal binaural hearing. The Hum Test demonstrated high sensitivity (89.7%-93.1%) and specificity (100%), and results were comparable to the Weber test. Results from the Hum Test and Weber Test also showed statistical agreement.

Considering the test requires no equipment and can be administered remotely, it may have good utility for the clinician. Besides screening for acute or subacute CHL, the high specificity of the test allows the clinician to also confidently decipher when conductive pathology (i.e. otitis media with effusion) subsides (when the test no longer lateralizes).[4]

As the Hum Test is thought to work similarly to the Weber Test, it should not be applied to subjects with bilateral hearing change or mixed (SNHL/CHL) pathology.[5] Future studies examining the Hum Test should assess its efficacy in detecting sudden SNHL as recent work has demonstrated good diagnostic performance with the Weber Test.[6]

REFERENCES

1. 3M Featured Products. 3M E-A-R Classic Ear Plugs: Attenuation. Available at: http://solutions.3m.com/wps/portal/3M/en_EU/PPE_SafetySolutions_EU/Safety/FeaturedProducts/EAR_Classic/. Accessed February 2, 2015.
2. Chole RA, Cook GB. The Rinne test for conductive deafness. A critical reappraisal. *Arch Otolaryngol Head Neck Surg*. 1988;114(4):399-403.
3. Fligor B. The Assessment of Hearing and Middle-Ear Function in Children. In: Bluestone and Stool’s: Pediatric Otolaryngology, 5th edition. People’s Medical Publishing House- USA, Ltd. 2013: 317-354.
4. Brown JL. Humming test for conductive hearing loss. *Lancet*. 1995; 346(8967):128.
5. Yung MW, Morris TM. Tuning-fork tests in diagnosis of serous otitis media. *Br Med J (Clin Res Ed)*. 1981;283(6306):1576.
6. Shuman AG, Li X, Halpin CF, Rauch SD, Telian SA. Tuning fork testing in sudden sensorineural hearing loss. *JAMA Intern Med*. 2013;173(8):706-707.