Accuracy of Tinnitus Frequency Matching Using a Web-Based Protocol

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ABSTRACT
The accuracy of a web-based protocol for tinnitus frequency matching in compare to audiometry was investigated. Twenty subjects had tinnitus frequency matching using an audiometer in an anechoic chamber. The subjects then matched their tinnitus at a desktop computer in an exam room using web-based software with a multiple-choice protocol and a slider. Octave challenge testing was performed. Median tinnitus frequency was 6000Hz (range, 2000-12000Hz) using the audiometer and self-directed multiple-choice protocol. Using the slider, the median frequency was 5925Hz (range, 1850-16000Hz). The patients with tinnitus frequency of over 12000Hz experienced a higher level of satisfaction when using the computer-based slider system. A web-based protocol for tinnitus frequency matching was as accurate as a standard audiometric protocol. An octave challenge test is necessary for a patient-directed tinnitus frequency matching.

INTRODUCTION
Subjective tinnitus is perception of a phantom sound in one or both ears. Of several introduced treatments, sound therapies are the most widely used option. Since tinnitus is a subjective sensation, its quantification is mainly dependent on patient-directed answers. One of the standard measurements in the evaluation process is quantifying the tinnitus frequency. This helps to classify patients into low, mid or high frequency tinnitus and is the basis for some customized sound therapies. The standard method to quantify tinnitus frequency is to use an audiometer to present pure tones or narrow-band noises and ask the patient if their tinnitus has a higher or lower pitch. With advancements in the treatments of tinnitus, the need for a simple patient-directed automated tinnitus assessment is urging.

In the current study, we aimed to evaluate the accuracy of a novel web-based protocol for tinnitus frequency matching compared to standard audiometry.

METHODS
• Audiometry
  Using an 8 GSI 16 audiometer and insert earphones in a double-walled soundproof room, tones were presented at 10–20 dB Sensation Level (SL). Starting with 1000 Hz, participants were asked if the pitch of their tinnitus was higher or lower than the pitch of the tone. The test was continued in this manner to narrow down the tinnitus frequency to within an octave. Intercalate frequencies were then presented the same way to determine a pitch match to the closest half octave. Octave challenge testing was performed by presenting tones an octave higher and an octave lower to identify the final frequency match.

• Web-based:
  Using a desktop computer in an exam room with AirDrives Interactive Stereo Earphones (Figure 1.) subjects were first asked whether their tinnitus is a ringing/tonal or buzzing/hissing sound. Then a multiple choice and a slider protocol were given (available at www.beyondtinnitus.com).

• Multiple-choice protocol: Participants were given a series of choices of different sound frequencies (250 Hz to 12000 Hz in 5 octave steps). Pure tones were used for tone/ringing tinnitus and narrow band noises for hissing/buzzing tinnitus. After selecting the closest sound, octave challenge testing was performed (Figure 2).

• Slider protocol: Participants used a scrolling slider to select the closest match. The slider frequency range was from 20 to 20000 Hz (Figure 3).

• After completing all steps, participants were asked to indicate the preferred methodology (audiometry vs. multiple choices vs. slider), and the method that resulted in the closest pitch match. Non-parametric tests were used to evaluate the results.

RESULTS
• As shown in Table 1, the female to male ratio was 7/13. The age ranged between 30 and 77 years with median of 53.5. Median tinnitus frequency was 6000Hz (range, 2000-12000Hz) using the audiometer and multiple-choice self-directed protocol.

  • Using the multiple-choice protocol, five participants (25%) experienced octave confusion at the first step (matched to a frequency one octave below or above) that accurately matched their tinnitus frequency after the octave challenge step. With the multiple choice protocol, all participants had the same tinnitus frequency as with audiometry (p<0.001).

  • Using the slider, the median frequency was 5925Hz (range, 1850-16000Hz). There was a strong, positive correlation between slider and audiometry tinnitus frequencies (r=0.97, p<0.001). There was a high level of internal consistency of the responses to all tests (Cronbach’s alpha=0.98).

• Eight participants (40%) preferred the web-based tests to audiometry and the rest had no preference. Forty five percent (9/20) indicated that the multiple-choice protocol had the closest match to their tinnitus frequency. Other responses included slider 40% (8/20), audiometry 10% (2/20) and all equal 5% (1/20). Among those who did not select audiometry (18/20), 67% preferred the multiple choices and 33% the slider.

• Among participants with tinnitus frequency of 12000Hz by audiometry (4/20), three chose a higher frequency using the slider as 12100, 14100 and 16000 Hz and all indicated the slider protocol as the most accurate.

DISCUSSION
Our findings revealed that a web-based protocol for tinnitus frequency matching could be as accurate as standard audiometry protocol. Furthermore, some audiometers or computer-assisted methods have a limitation of 12000 Hz to present and therefore, tinnitus frequency of patients with high pitch tinnitus might not be accurately assessed. Patients with very high frequency tinnitus preferred a web-based slider: Patients may inaccurately identify their tinnitus frequency as one octave above or below, therefore, an octave challenge test is necessary for patient-directed tinnitus frequency matching. We attempted to introduce a new, simple, cost-effective and reliable method to quantify the tinnitus frequency. The validity of the matches could not be evaluated since there is now way to directly measure a phantom sensation. Future studies with larger sample sizes and repeated measures are required to evaluate the web-based protocols for tinnitus frequency matching further.

CONCLUSION
• A web-based tinnitus matching protocol is as effective as a standard protocol using an audiometer in identifying the patient’s tinnitus frequency.

  • A slider-based matching system is more effective for high frequency tinnitus than the standard protocol.

  • An octave-test is a necessary element of a web-based tinnitus frequency matching.

  • Most patients preferred the web-based matching test because they felt more control over the testing and the rapidity of the protocol.

REFERENCES