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Bedside Evaluation of Hearing: A comparrative Evaluation of 4 Frequencies

ABSTRACT

Background: Tuning fork tests are commonly performed for bedside evaluation of hearing. There is a controversy about the most useful frequency of tuning fork for the bedside testing of hearing. **Methods:** In the present study, the sensitivity and specificity of Rinne and Weber test were calculated using 128, 256, 512, and 1024 frequencies in 50 successive patients referred for evaluation of hearing. Pure tone audiometry formed the standard reference. **Results:** Rinne test showed poor sensitivity (32%, 32%, 17%, and 15% with 128 Hz, 256, 512, and 1024 Hz tuning forks, respectively), but good specificity (98%) for detecting conducting hearing loss. Weber test showed good sensitivity for detecting unilateral hearing loss (71%, 92%, 85%, and 71%) and poor specificity (44–50%). Sensitivity improved with higher degrees of hearing loss. **Conslusions:** The present study found that the 256 Hz tuning fork was more sensitive than the 128, 512, and 1024 Hz forks for evaluation of Rinne as well as Weber test. Hence, 256 seems to be the most suitable frequency for bedside testing of hearing.

Key words: Tuning fork test, Frequency, Sensorineural hearing loss

Satish Vasant Khadilkar[1], Madhu Bala Singla[1], Jyotsna Nadkarni[2]

[1]Dean, BHIMS and Head of the Department of Neurology, Bombay Hospital Institute of Medical Sciences, Mumbai, Maharashtra, India, [2]Department of Audiology, Bombay Hospital Institute of Medical Sciences, Mumbai, Maharashtra, India

Corresponding Author:
Madhu Bala Singla, Department of Neurology, Bombay Hospital Institute of Medical Sciences, Mumbai, Maharashtra, India.
E-mail: madhusingla58@gmail.com

INTRODUCTION

Tuning fork tests are commonly performed for bedside evaluation of hearing. Even though these have been used by clinicians for many decades, uncertainty exists as regards the most useful frequency. 128, 256, 512, and 1024 Hz frequencies have been utilized by various studies and 256 and 512 have been found to be more suitable than the other two frequencies.[1,2] There are differences in the perceived utility of these two frequencies as specificity and sensitivity issues have been documented with either of the two, along with false-positive results.

We conducted this study to determine the accuracy of four standard frequencies of tuning forks and using pure tone audiometry as the standard reference to determine the most appropriate frequencies for bedside evaluation of hearing.

METHODS

The study was carried out between January 2017 and December 2017 in the audiology and neurology departments of a tertiary care teaching hospital setting. Consecutive subjects referred for evaluation of hearing were studied. Preliminary data were collected (age, sex, chief symptoms, and diagnosis). Rinne and Weber tests were performed using 128, 256, 512, and 1024 Hz tuning forks and using standardized methods.[3] For the Rinne test, responses were classified as Rinne positive if the sound by air conduction was heard longer than that by bone conduction, Rinne was interpreted as negative when bone conduction was perceived longer than air conduction. For the Weber test, the vibrating tuning fork was placed in the midline on the forehead. Lateralizing responses indicated unilateral hearing loss. Immediately following the clinical testing, an audiologist carried out tonal audiometry, blinded to the bedside test results. The results of all four frequencies were compared with the pure tone audiometry. Pure tone threshold was recorded at following frequencies 250, 500, 1000, 2000, and 4000 Hz. Hearing loss was defined as thresholds 25 dB at one or more frequency in either ear and classified as mild (26–40 dB), moderate (41–55 dB), and severe (55–80 dB).[4]

RESULTS

Fifty consecutive patients (100 ears) were evaluated.

Rinne test

34/100 ears had conductive hearing loss on audiometry, out of which Rinne test (with 128, 256, 512, and 1024 Hz frequencies) identified BC >AC in 11, 11, 6, and 5 subjects, respectively. There was an overlap of subjects with different frequencies which showed true positive results. Rest 23 out of 34 showed false-negative results with all four frequencies. One out of the 66 ears without conductive deafness showed BC >AC with all frequencies. Thus, sensitivity of the Rinne test in detecting conductive hearing loss was low (32%, 32%, 17%, and 15% with 128 Hz, 256, 512, and 1024 Hz tuning forks, respectively). The sensitivity was more with higher degrees of conductive hearing loss (>40 dL). At hearing loss of 20–40 dL, sensitivity was 31%, 31%, 9%, and 9% with 128 Hz, 256, 512, and 1024 Hz tuning forks, respectively, which increases to 100% with all frequencies except 1024 with hearing loss >40 dL), as shown in Figure 1, suggesting that 128 and 256 are more sensitive than 512 and 1024 for smaller degree of hearing loss. Specificity, on the other hand, was high (98.5%) with each frequency, indicating very low chances of a false-positive result.

Weber test

For Weber test analysis, subjects with unilateral hearing loss on audiometry were identified. Fourteen out of 50 subjects had unilateral hearing loss on audiometry and out of these 13 had conductive hearing loss and one patient had high-frequency sensorineural hearing loss (SNHL). Weber test using 128, 256, 512, and 1024 Hz frequencies identified 10, 13, 12, and 10 subjects, respectively, the true positive results. There was an overlap of subjects with different frequencies which showed true positive results. One patient which was missed by all frequencies had high-frequency SNHL, the false negative. Sixteen subjects had equal hearing loss on both sides, out of which eight subjects showed lateralizing responses with 128, 256, and 1024 frequencies and seven subjects with 512 Hz, the false-positive results. Interestingly, same eight subjects showed false-positive results with all frequencies except one which showed true negative result with 512 Hz. Twenty subjects had bilateral asymmetric and mixed hearing loss on audiometry, hence, they were not considered for analysis. Sensitivity of Weber test in detecting unilateral hearing loss was 71%, 92%, 85%, and 71% with 128, 256, 512, and 1024 Hz frequencies, respectively. It increased with higher degrees of unilateral hearing loss (>40 dB), at 20–40 dL hearing loss sensitivity was – 0%, 75%, 75%, and 0%; which increases to 100%, 100%, 89%, and 100% with hearing loss >40 dL with 128 Hz, 256, 512, and 1024 Hz tuning forks, respectively, as shown in Figure 2. Specificity was 44% with 128, 256, and 1024 Hz and 50% with 512 Hz.

Thus, for the Rinne test, sensitivity of 128 and 256 tuning forks frequencies was superior to the other two frequencies while the specificity was comparable for all frequencies. For Weber test, sensitivity of 256 Hz was highest but specificity for all frequencies was low. Comparative results of different frequencies did not reach statistical significance ($P > 0.05$).

DISCUSSION

In the present study, sensitivity of 256 Hz was better for both Weber and Rinne tests, without compromising specificity. Hence, the frequency 256 seems best suited for bedside hearing tests. One previous study compared 256, 512, 1024, and 2048 and 512 was found to be the best suited frequency for bedside hearing tests. This study detected a high false-positive rate with 256 Hz, even though the sensitivity of 256 was highest.[1] Another study compared only 256 and 512, which showed better results with 256 without any high false-positive rates.[2] Results of the present study are compatible with this study, in terms of the analyzed frequencies.

One hundred and twenty-eight which is routinely utilized for sensory examination (vibration testing) was not compared in these studies.[1,2] In our study, it shows good sensitivity on Rinne testing, suggesting that it can be utilized for performing the same, but for Weber testing, its sensitivity is low.

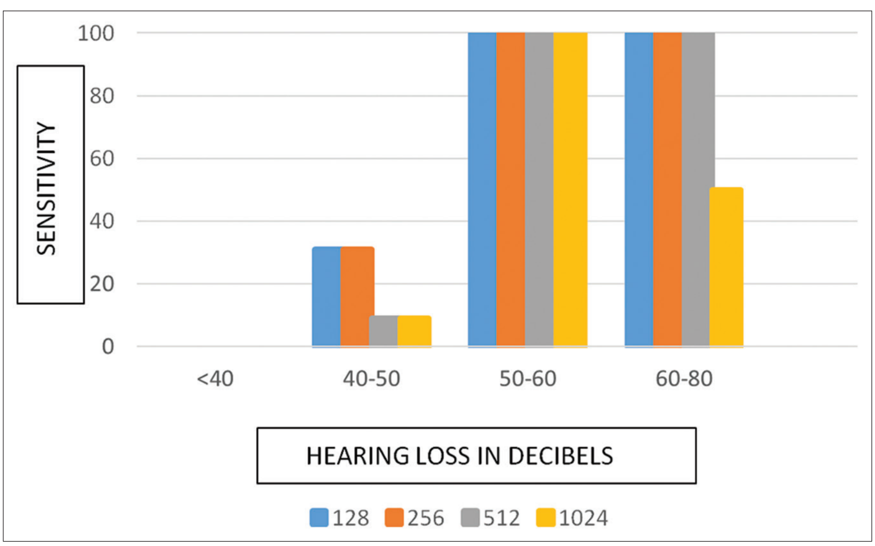

Figure 1: Rinne test

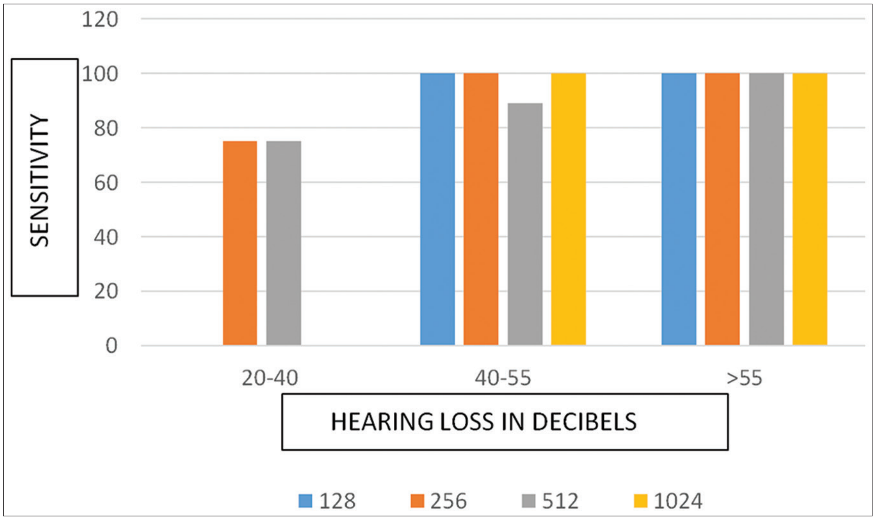

Figure 2: Weber test

Also for Rinne test, 128 and 256 have better sensitivity for lower degrees of conducting hearing loss which can be missed with 512 and 1024.

One thousand and twenty-four has low sensitivity for both Rinne and Weber, hence testing with it should be avoided.

Sensitivity of both Rinne and Weber tests was low when the hearing loss was <40 dL and it improved with higher degrees of hearing loss (>40 dL) which is compatible with previous reports.[2,5] Poor diagnostic accuracy of tuning fork tests is consistent with previous reports.[6,7] Moreover, tuning fork tests are useful only to identify unilateral (Weber) or conductive (Rinne) hearing loss as these tests can miss subjects with bilateral (Weber) and SNHL (Rinne). A negative Rinne test can be helpful to differentiate between conductive hearing loss and other conditions (specificity >95%).

CONCLUSIONS

This small study indicates that 256 is the overall most productive frequency for the bedside evaluation of hearing. The specificity and sensitivity of various frequencies improve with higher degree of hearing deficit. One hundred and twenty-eight normally used for vibration testing, can also be used for performing Rinne test if 256 is not available.

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