Re – evaluation of Rinne Test with Aluminum Alloy Tuning Fork 256 Hz and 512 Hz

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ABSTRACT

Objective: To study the sensitivity, specificity and accuracy of the 256 Hz and 512 Hz aluminum tuning fork in the detection of conductive hearing loss by quick Rinne test.

Methods: The patients with hearing problems recruited from out-patient unit were tested with the 256 Hz and 512 Hz aluminum quick Rinne test. The audiometry was performed on the same day and the results were compared.

Results: During the study period, 246 ears with conductive hearing loss and 246 ears with non-conductive hearing loss were recruited. The 256 Hz Rinne test had higher sensitivity than the 512 Hz Rinne test (93.83% and 71.95% respectively). The specificity and accuracy of the 512 Hz Rinne test was markedly greater than the 256 Hz Rinne test (91.18 % vs. 26.7% specificity and 83.57% vs. 61.85% accuracy). The 512 Hz Rinne test had sensitivity over 80% when the air-bone gap was equal to or greater than 20 dB. The sensitivity was even higher (more than 90%) if the air-bone gap was equal to or greater than 30 dB.

Conclusion: This study demonstrated that the 512 Hz Rinne test had better accuracy than the 256 Hz Rinne test for the diagnosis of conductive hearing loss. The 512 Hz Rinne test can detect the air-bone gap of 30 dB or greater which indicates the surgical role with the sensitivity more than 90%. We recommend that 512 Hz Rinne test should be used as a screening tool for the detection of conductive hearing loss.

Keywords: Rinne; tuning fork; accuracy; conductive hearing loss; air-bone gap (Siriraj Med J 2019;71: 127-130)

INTRODUCTION

The tuning fork test for hearing evaluation has long been widely used. Various techniques for tuning fork usability were developed; for instance, Weber test, Bing occlusion test, Schwaback test and Rinne test. However, the Rinne test is primarily used as one of the bedside tools in the evaluation of patients with hearing problem.

Despite the easily accessibility of the audiometry which is considered as a gold standard for hearing diagnosis, tuning fork 256 Hz and 512 Hz were still recommended for general practitioners and otoneurologists for several circumstances; for example, screening for conductive hearing loss, pre-and post- operative evaluation of middle ear surgery[1] and detection of the air-bone gap. Even though, several researches have tried to evaluate the value of tuning fork since 1980s[2], the results had wide variation. One study[3] suggested that a 512 Hz tuning fork should be used for screening patients with conductive hearing loss. However, another study advised to use 256 Hz tuning fork instead.[3] Also, the tuning fork material is another issue to consider for the various results. Many studies didn't mention tuning fork material.[2,3,4] Also, one study used uncommon material such as metal tuning fork which is rarely used in ordinary practice.[5]

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Our study aimed to re-assess the accuracy, specificity, and sensitivity of the 256 Hz and 512 Hz aluminum tuning fork test by performing quick Rinne test as the primary objective. The secondary objectives were the following;

1. To determine how to interpret equivocal Rinne test
2. To determine the results of tuning fork test in comparison with the air-bone gap.

The findings from this study will guide us for the way to evaluate of hearing problem patients in out-patient clinic and primary care unit.

MATERIALS AND METHODS

This cross-sectional study was approved by the Siriraj Institutional Ethical Committee (Si 587/2015). Subjects were recruited from the out-patient otolaryngology clinic during May 2015 to July 2016. Routine history taking and otological examination were performed in individual patients. The patients with the age of 18 years and older suspicious for abnormal hearing were recruited.[6] The exclusion criteria was patients with learning or psychological problems. The procedure was started with the quick Rinne test performed on both ears by a group of well-trained doctors in the tightly closed room (estimate background noise of 53.2 dBA SPL). The examiners were blinded from both patients' diagnosis and otological examination. The Rinne test was performed using 256 Hz and 512 Hz aluminum tuning fork by the loudness comparison method (quick Rinne test).[7]

The vibrating tuning fork was placed firmly behind the pinna (BC position) for few seconds then moved to the front of the ear canal approximately 2 to 2.5 centimeters from the tragus with parallel position to the skull (AC position). The examinee would be asked to compare the loudness of each position. Which site was louder?[2] The results were recorded in 3 categories: negative Rinne test when the examinee heard louder when placing tuning fork on the mastoid bone than when holding in front of the ear (BC>AC), positive Rinne test when the examinee heard louder while holding the fork in front of the ear than placing on the mastoid bone (AC>BC), and equivocal Rinne test when the examinee could not tell the difference between the two positions (AC=BC).

We classified the examinee into 2 groups: conductive hearing loss group and nonconductive hearing loss group. The calculated number for each group was 246 ears which were collected in order to avoid the bias. The profound sensorineural hearing loss ears were excluded from the study.

RESULTS

There were 296 cases recruited in this study. Most of them are women (61.5%). Age ranged between 18 to 87 years with the mean age of 54.4 years (S.D. 15.22). Demographic data are shown in Table 1.

Data recorded when performing the test with 256 Hz tuning fork was mostly negative Rinne test on both conductive hearing loss (92.6%) and nonconductive hearing loss (65.85%) groups. When using 512 Hz tuning fork, the negative Rinne test was recorded in 71.95% of conductive hearing loss subjects. Whereas, the positive Rinne test was reported in 86.5% of nonconductive hearing loss subjects.

The equivocal result was recorded in similar amount of 5% in both conductive and nonconductive hearing loss group either performing with 256 Hz or 512 Hz tuning fork. Interestingly this equivocal result lead to nonconductive situation in 256 Hz tuning fork while this leads to no clue in 512 Hz tuning fork. All results from all tests in this study are shown in Table 2.

The data was calculated with the exclusion of equivocal results for sensitivity, specificity, accuracy, positive predictive value and negative predictive value of 256 Hz and 512 Hz quick Rinne test. Therefore, the number of the tested ears decreased to the final of 464 ears in 256Hz tuning fork group and 465 ears in 512Hz tuning fork group.

As the result, the 256 Hz Rinne tuning fork test has very high sensitivity (93.83%), low specificity (26.7%), and moderate accuracy (61.85%). However, all the data in 512 Hz tuning fork group was higher than 256 Hz tuning fork group except for the sensitivity. (Fig 1)

TABLE 1. Demographic data.

Data	Number (%)
Sex	
Male	114 (38.5)
Female	182 (61.5)
Education	
Uneducated	2 (0.7)
Grade 1-6	75 (25.3)
Grade 7-12	56 (18.9)
Diploma	24 (8.1)
Undergraduate	139 (47%)
Number of used ear	
Unilateral	100 (33.8%)
Bilateral	196 (66.2%)

TABLE 2. Results of 256 Hz and 512 Hz Rinne tuning fork test.

	Conductive hearing loss		Nonconductive hearing loss	
	256 Hz (246 ears)	512 Hz (246 ears)	256 Hz (246 ears)	512 Hz (246 ears)
	Number (%)	Number (%)	Number (%)	Number (%)
Rinne negative	228 (92.6)	177 (71.95)	162 (65.85)	19 (7.72)
Rinne positive	15 (6.09)	56 (22.76)	59 (23.98)	213 (86.5)
Rinne equivocal	3 (1.21)	13 (5.28)	25 (10.16)	14 (5.69)

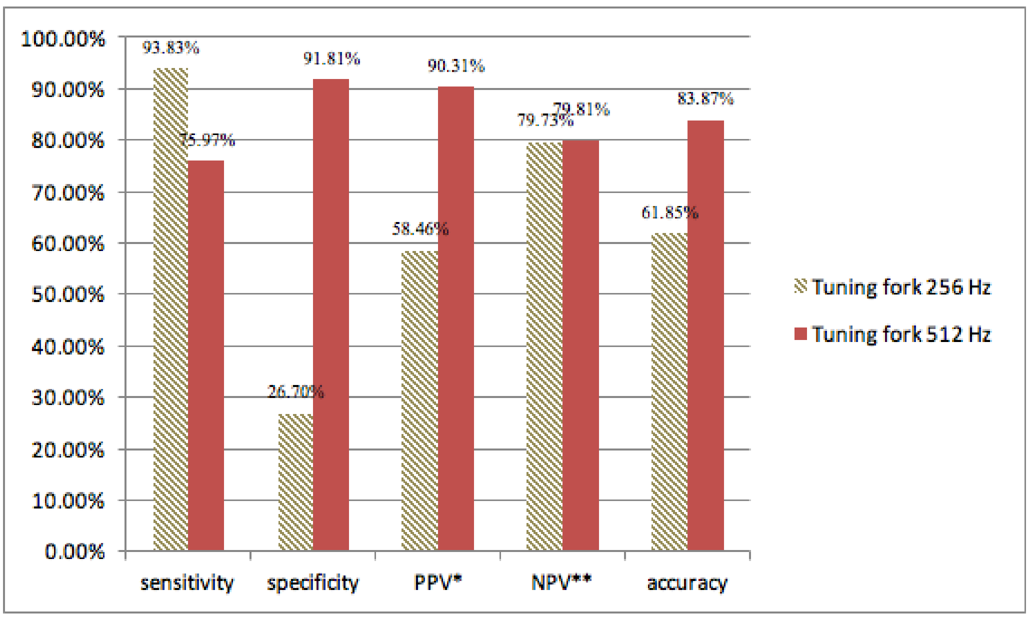

Fig 1. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of 256 Hz compare with 512 Hz Rinne tuning test. (*positive predictive value, **negative predictive value)

In this study authors used the average air-bone gap according to Committee on Hearing and Equilibrium guidelines for the evaluation of results of treatment of conductive hearing loss.[9] From the results, different frequencies tuning forks had different power to determine conductive hearing loss. The 256 Hz tuning fork had very high power (92.7%) to detect conductive hearing loss even with only 10 dB air-bone gap. Whilst, 512Hz tuning fork would have a high power (91.9%) to detect conductive problem if the air-bone gap is greater than 30 dB air-bone gap. (Fig 2)

DISCUSSION

Despite the low specificity of 256 Hz tuning fork, the sensitivity of 256 Hz Rinne tuning fork test is greater than 512 Hz tuning fork test (Fig 1). This yield the similar result as previous studies of Burkey et al[2] and Chole et al.[3]

Burkey et al[2] suggested that the sensitivity of equivocal Rinne test in conductive hearing loss can be improved by applying 512 Hz tuning fork.

Chole et al[3] and Browning et al[4] reported that whether they included equivocal results of tuning fork test or not, the sensitivity and specificity were not different. We found that the equivocal Rinne test comprised of 5% of subjects and our data showed that the results did not correlate with either positive nor negative Rinne test.[3,4] For this reason, we did not include the equivocal Rinne test in the calculation for sensitivity and specificity.

Rinne's sensitivity of detecting conductive hearing loss in each range of air-bone gap is essential for clinical

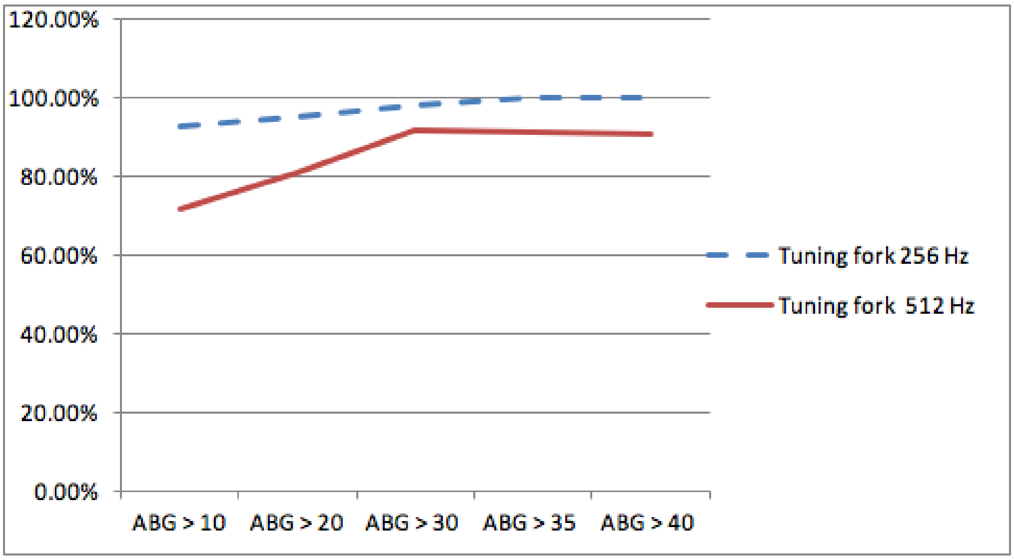

Fig 2. Sensitivity of air-bone gap detection of 256 Hz and 512 Hz Rinne tuning fork.

appliance. Crowley et al[8] studied between the Rinne tuning fork test 256, 512, 1024, and 2048 Hz in 153 ears and air-bone gap detection. He concluded that the air-bone gap equal to 20 dB or over was necessary for Rinne test to distinguish a conductive hearing loss. Burkey et al[1] studied the 512 Hz Rinne test of conductive hearing loss ears, and he concluded that Rinne's sensitivity for the detection of conduction loss equal to 20 dB or greater was 94.9%. Our study showed that 512 Hz tuning fork can detect 20 dB conductive problem or greater with the sensitivity of 81%. Moreover, the sensitivity reached to 92.3% if the conductive problem was 30 dB or greater. Therefore, we can conclude that the 512 Hz tuning fork is appropriate for pre-operative and post-operative evaluation in conductive hearing loss patients or unquestionable otosclerotic patients.

CONCLUSION

This study showed two important results. Firstly, the study showed that the 512 Hz Rinne test has more accuracy than 256 Hz Rinne test and can be a workhorse of screening conductive hearing loss in clinical practice. Secondly, the 512 Hz tuning fork can detect air-bone gap of 30 dB or greater which indicates surgical role with the sensitivity of 92.3%.

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