Original Research Article

Utility of Rinne's tuning fork test for quantitative assessment of conductive hearing loss

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ABSTRACT

Background: The Rinne tuning fork test is used routinely in clinical ENT examination. It is used to assess the person's hearing acuity. Ideally, 3 tuning forks are used 256, 512 and 1024 Hz. Rinne tuning fork tests can be used to diagnose conductive hearing loss. Aim of our study an attempt is made to find the utility of three different tuning forks (256, 512, 1024 Hz) for quantification of conductive hearing loss and their accuracy.

Methods: A retrospective study with a sample size of 300 was undertaken over 12 months from April 2018 to March 2019 at the out-patient department of ENT of VMKV medical college and hospital, Salem. Patients of both sexes and aged above 10 yrs presenting with conductive hearing loss due to varied etiology were subjected to complete ENT examination including Rinne test with three different tuning forks (256, 512, 1024 Hz).

Results: The results of all the tuning forks (256, 512, 1024 Hz) shows that 29 patients were Rinne's positive to all tuning forks had the air-bone gap range of 15 dB to 19 dB with a mean air-bone gap of 17.63 dB. 83 patients were negative to 256 Hz tuning fork but positive to 512 and 1024 Hz tuning forks had the air-bone gap range of 20 to 29 dB with a mean air-bone gap of 25.46 dB.

Conclusions: We conclude that Rinne's tuning fork test can be used to quantify the degree of conductive hearing loss into mild (20-30 dB), moderate (30-45 dB), and severe (45-60 dB).

Keywords: Rinne test, Tuning forks, Conductive hearing loss, Utility

INTRODUCTION

The standard loudness comparison method of performing the Rinne test compares the relative loudness of air conduction against bone conduction. In ears with normal hearing or pure sensorineural hearing impairment, the tuning fork will sound louder opposite the ear canal (air conduction) than when placed on the mastoid bone behind the ear (bone conduction). Therefore, with the tuning fork activated, the patient is asked to say which of the following sounds louder: the fork placed within 2cm of the external auditory canal or placed firmly on the flat bone of the mastoid behind the pinna.¹ To aid bone contact with the tuning fork base it is advisable to hold the patient's head with the other hand to prevent it from

moving. The alternative method of performing the Rinne test is the threshold comparison method. Here, the activated fork is held opposite the external canal until it is no longer heard. It is then placed on the mastoid bone.² If the sound is heard again, then bone conduction is better than air conduction and there is a conductive impairment. This method of performing the Rinne is not as reliable as the relative loudness comparison method. For the Rinne test, a vibrating tuning fork (typically 512 Hz) is placed initially on the mastoid process behind each ear until the sound is no longer heard. Then, without re-striking the fork, the fork is then quickly placed just outside the ear with the patient asked to report when the sound caused by the vibration is no longer heard.³ A normal or positive Rinne test is when sound is still heard when the tuning

fork is moved to air near the ear (air conduction or AC), indicating that AC is equal or greater than (bone conduction or BC). Therefore, AC>BC; which is how it is reported clinically for a normal or positive Rinne result. In the conductive hearing loss, bone conduction is better than air or BC>AC, a negative Rinne, and the patient will report that they do not hear the fork once it is moved.⁴ The Rinne test is not ideal for distinguishing sensorineural hearing loss, as both sensorineural hearing loss and normal hearing report a positive Rinne test (though the sensorineural patient will have a decreased duration of hearing sound once the fork is moved to air). Although many clinicians use a 516 Hz tuning fork, the 256 Hz fork gives superior sensitivities and specificities.⁵ The 256 Hz Rinne tuning fork test will detect a conductive defect above 30 dB in 90% of patients. Between 20 and 30 dB, the sensitivity will fall to 70% and between 10 and 20 dB, it will be less than 50%. The specificity of the test is high above 30 dB conductive defect but falls as the air-bone gap narrows. By using 256 and 1024 Hz tuning fork along with 512 Hz tuning fork conductive hearing loss can be quantified. This quantification value varies, as given by Miltenburg.⁶

METHODS

A retrospective study with a sample size of 300 patients was done over 12 months from April 2018 to March 2019 at OPD of ENT department of VMKVMCH, Salem. Patients of both sexes and aged above 10 years and well cooperative with complaints of conductive hearing loss due to varied etiology were included in our study. All patients were subjected to complete ENT clinical examination, routine blood investigations. Following this Rinne's tuning fork test was done to all patients with three tuning forks (256, 512, 1024 Hz). The results were obtained, calculated, compared and correlated with an audiometric air-bone gap in PTA and terms of mild, moderate and severe conductive hearing loss

Statistical analysis

Data entry was made in the Microsoft Excel software in codes and analysis was done with an SPSS-20 computer package. Categorical variables are expressed as percentages whereas continuous variables are expressed as mean $\pm$ standard deviation. Association between the categorical variable was found by the chi-square test and the relationship between the continuous variable was assessed by Student's t-test $p < 0.05$ was considered as statistically significant.

RESULTS

It is seen from (Table 1) that the majority of the population is in the age group of 41-50, which shows that the majority of the population are males and the male to female ratio is 1.2:1. The mean age of the study population was 44.5 years.

Table 1: Age wise distribution of study population.

Age (years)	Frequency	Percentage
15-30	44	14.7
31-40	41	13.7
41-50	122	40.7
51-60	84	28.0
61-70	9	3.0
Total	300	100

The frequency of causes for conductive hearing loss (Table 2), which shows CSOM as the most frequent cause for conductive hearing loss. Adhesive otitis media is the second most frequent cause followed by traumatic perforation followed by impacted wax followed by otosclerosis. Tympanosclerosis the least cause of conductive hearing loss.

Table 2: Disease distribution among the study population.

Diagnosis	Frequency	Percentage
Adhesive otitis media	25	8.33
CSOM	217	72.33
Impacted wax	16	5.33
Otosclerosis	12	4.00
Traumatic perforation	22	7.33
Tympanosclerosis	8	2.67
Total	300	100.00

Tuning fork test results (Table 3) show that among 300 patients 270 were negative to 256 Hz tuning fork, 189 were negative to 512 Hz and 63 were negative to 1024. Majority of patients were negative to 256 Hz.

Table 3: Tuning fork test results among study group.

	Positive		Negative	
	Frequency	%	Frequency	%
TF 256	30	10.0	270	90.0
TF 512	111	37.0	189	63.0
TF 1024	237	79.0	63	21.0

The results of all the tuning forks (256, 512, 1024 Hz) as shown in Table 4 which shows that 29 patients were Rinne's positive to all tuning forks had the air-bone gap range of 15 dB to 19 dB with a mean air-bone gap of 17.63 dB. 83 patients were negative to 256 Hz tuning fork but positive to 512 and 1024 Hz tuning forks had the air-bone gap range of 20 to 29 dB with a mean air-bone gap of 25.46 dB. 125 patients were negative to 256, 512 Hz tuning forks but negative to 1024 Hz tuning fork with air-bone gap range of 31 to 44 dB with a mean air-bone gap of 37.22 dB. 63 patients were negative to all the three tuning forks with air-bone gap range of 46-59 dB mean air-bone gap of 49.73 dB and the p value is 0.0001 ($p < 0.005$).

Table 4: Combined results of Rinne's tuning fork test with 256, 512, 1034 Hz tuning forks.

Rinne's tuning fork test			Estimated CHL	Frequency	%	A-B gap		P value (ANOVA)
256 Hz	512 Hz	1024 Hz				Mean	Std. deviation	
+	+	+	Normal	29	9.7	17.63	1.571	0.0001
-	+	+	20-30 dB	83	27.7	25.46	2.852	
-	-	+	30-45 dB	125	41.7	37.22	3.854	
-	-	-	45-60 dB	63	21	49.73	3.867	
Total				300	100			

Table 5: Range of hearing loss corresponding to degree of hearing loss.

Degree of hearing loss	Range of hearing loss	Frequency	Percent	Mean	Std. deviation
Normal	15 to 19 dB	29	9.7	17.63	1.571
Mild	20 to 29 dB	83	27.7	25.46	2.852
Moderate	31 to 44 dB	125	41.7	37.22	3.854
Severe	46 to 59 dB	63	21	49.73	3.867
Total		300	100		

Table 6: Comparison of degree of conductive hearing loss of both pure tone audiometry and Rinne tuning fork test.

Pta	Rinne's tuning fork test				Total
	Normal	Mild	Moderate	Severe	
Normal	15	1	3	0	19
Mild	6	67	8	6	87
Moderate	4	13	104	6	127
Severe	4	2	10	51	67
Total	29	83	125	63	300

The patients were subjected to pure tone audiometry and the frequency distribution of conductive hearing loss is shown in Table 5, which shows that majority of patients have moderate conductive hearing loss (42.3%) followed by mild conductive hearing loss (29%) followed by severe conductive hearing loss (22.3%). The mean air-bone gap in pure tone audiometry was 35.36.

Comparison of the results of the degree of conductive hearing loss recorded with pure tone audiometry is compared in Table 6. It shows that the results obtained with Rinne tuning fork test are same as that of pure tone audiometry i.e. 67 patients had mild conductive hearing loss with both Rinne tuning fork test and pure tone audiometry, 104 patients had moderate conductive hearing loss with both Rinne tuning fork test and pure tone audiometry and 51 patients had severe conductive hearing loss with both Rinne tuning fork test and pure tone audiometry. The p value was 0.0001 (<0.005).

DISCUSSION

The purpose of the outer ear is to direct sounds onto the tympanic membrane. The sound vibrations are then transmitted through the middle ear via the ossicular chain before it reaches the cochlea. The cochlea plays an important role in transducing these vibrations into nerve

impulses via the auditory nerve (vestibulocochlear nerve) which is then delivered along the central pathways to the auditory cortex where it is processed and perceived as sound. This pathway is termed air conduction. However, sound can also be transmitted via bone conduction where vibrations are transmitted via the skull and delivered directly to the cochlea which is buried within the temporal bone.⁷ Hearing loss may occur due to interruption at any point along these pathways. Rinne's tuning fork test is the most commonly used test in OPD to identify conductive hearing loss. The results of Rinne's tuning fork test can be confirmed with pure tone audiometry. In our study, we compared the results of the degree of conductive hearing loss obtained with the Rinne tuning fork test with that of results obtained with pure tone audiometry. In our study majority of patients were males (55.0%) and females were (45%). The most frequent age group was 41-50 years (40.7%) and the mean age was 44.5.⁸ Kelly et al found in their study that CSOM is the common cause of adult conductive hearing loss. Our study is on par with it and CSOM at a frequency of 72.3% (217 patients). When patients were subjected to Rinne's tuning fork test, 270 patients (90%) were negative for 256 Hz tuning fork, 189 patients (63%) were negative for 512 Hz tuning fork and 63 patients (21%) were negative to 1024 Hz tuning fork.⁹ The results of all the tuning forks (256, 512, 1024 Hz) show that 29

patients were Rinne's positive to all tuning forks had the air-bone gap range of 15 dB to 19 dB with a mean air-bone gap of 17.63 dB.¹⁰ Eighty three patients were negative to 256 Hz tuning fork but positive to 512 and 1024 Hz tuning forks had the air-bone gap range of 20 to 29 dB with a mean air-bone gap of 25.46 dB. 125 patients were negative to 256, 512 Hz tuning forks but negative to 1024Hz tuning fork with air-bone gap range of 31 to 44db with a mean air-bone gap of 37.22 dB.¹¹ Sixty three patients were negative to all the three tuning forks with the air-bone gap range of 46-59 dB mean air-bone gap of 49.73 dB and the p value is 0.0001 ($p < 0.005$). this is in par with the values given by Miltenburg.¹² When compared the values of Rinne tuning fork test with that of pure tone audiometry values, we found that patients with mild conductive hearing loss were 67, patients with moderate conductive hearing loss were 104, and patients with severe conductive hearing loss were 51 and the p value is 0.0001 (< 0.005). this is in par with Browning, Swan IRC6 study on sensitivity and specificity of 256 Hz and 512 Hz tuning fork showing that our study was significant and Rinne's tuning fork test can be used to quantify the degree of conductive hearing loss.¹³⁻¹⁵

CONCLUSION

We conclude in our study that Rinne's tuning fork test can be used to quantify the degree of conductive hearing loss into mild, moderate, and severe when performed with 256 Hz, 512 Hz and 1024 Hz tuning forks. This will help give the clinician an idea about the degree of hearing loss before the patient is subjected to pure tone audiometry and also useful in places where the facility of pure tone audiometry is not available. This will guide the clinician to the need for further examination, investigation, and management. Also, the Weber and Rinne tuning fork tests can be used to confirm audiometric findings, particularly when the audiogram is not consistent with clinical findings. In the assessment of a patient with bilateral conductive hearing loss, the Weber test is a quick and useful test for the otorhinolaryngology (ENT) surgeon to help determine which side of the ear to operate on first. Usually, the ear with the more significant conductive hearing loss is preferred.

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