Tuning Fork Test As An Audiological Assessment Tool In Rural Areas Of India

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ABSTRACT

AIM: To study the utility of Tuning Fork test in quantitative assessment of Conductive Hearing Loss.

METHODOLGY:

A prospective study with a sample size of 500 was undertaken over 4 months from June 2021 to October 2021 at the out-patient department of ENT at IMCHRC, Indore. Patients of both sexes and aged above 10 years presenting with complaint of decreased hearing were subjected to complete ENT examination including Rinne's test with three different tuning forks (256, 512, 1024 Hz). Patients were further advised for Pure Tone audiometry. The results were obtained, calculated, compared and correlated with PTA in terms of mild, moderate and severe conductive hearing loss.

RESULTS:

It has been found that there is a strong correlation between Pure tone audiometry and Tuning fork test with p value <.05, showed correlation between both the methods.

CONCLUSION: Rinne's tuning fork test can be used for screening and can be used as an aiding tool to quantify degree of hearing loss before the patient is subjected to pure tone audiometry in places where the facility of PTA is not available.

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INTRODUCTION:

Hearing impairment is most frequent sensory deficit in human population. Globally, it is estimated that by 2050, over 700 million people i.e., 1 in every 10 people will complain of decrease hearing [1]. Low socioeconomic conditions, poor living standards, overcrowding with poor hygiene and inadequate access to proper medical facilities in the periphery contribute to the picture of decreased hearing. Consequences of hearing impairment leads to inability to understand speech sound, decreased capability to communicate, delay in language development, economic and educational backwardness, social isolation, and stigmatization [2]. So, there was need for a primary level of prevention. Early screening for hearing loss and early rehabilitation is recommended to reduce the disability caused by hearing impairment [3]. As there is no facility of audiology in rural sectors of India, our healthcare workers staying in periphery refer such patients to urban sectors and during this process of advising and lack of knowledge they are lost to follow up and show an iceberg phenomenon. So, there was a need for an aud-

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iological assessment tool that can be used to evaluate degree of hearing loss, and can be used as a method of screening, which should be cost effective and have a zero-learning curve.

Tuning Fork was invented in 1711 by British musician John Shore and originally served as a standard pitch instrument with later development for further uses [4]. A tuning fork (TF) consists of a base (footplate/shoulder), stem and two prongs. The sides of prongs which face one another are termed as inner normal faces and other sides which are parallel to these are called outer parallel faces. When a force is applied to an outer normal face and right angles to it the prongs are set in transverse vibration, and they approach alternately and separated from each other. The two nodal points which are situated in shoulders remain stationery and the intermodal segment vibrates in longitudinal axis of the prongs, this vibration is transmitted as longitudinal vibration to the stem. If struck correctly the tuning fork produces a comparatively pure tone whose frequency is remarkably constant. When testing hearing by air-conduction the fork should be held as close to the auricle as possible, without touching the protruding hair and such that the acoustic axis of the fork is coincident with the anatomic axis of the external acoustic meatus. The acoustic meatus corresponds to a line which is perpendicular to the normal faces of the fork, and which passes through the point equidistant from both the free end and parallel faces of the corresponding fork.

The tuning forks of 256, 512, 1,024 and 2,048 Hz2 (cycles/ second) are used. The tuning fork of 512 Hz is most important. The lower frequency TF produce sense of bone vibration while higher frequencies have shorter decay time. 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 [5]. 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. 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 [6]. A normal or positive Rinne test is when sound is still heard when the tuning 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 [7]. 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.

Pure tone audiometry determines a hearing threshold i.e., the lowest level in dB HL at which certain sounds can just be heard 50% of the time that it is presented at that level. Pure tone audiometry helps us to identify hearing

thresholds of an individual based on volume and pitch of the sound waves.

Aim: Utility of Tuning Fork test in quantitative assessment of Conductive Hearing Loss.

Objectives:

1. Rinne's Tuning Fork Test as a screening tool in hearing assessment.
2. To compare Rinne's Tuning Fork test with Pure Tone Audiometry

Materials And Methods: -

Study Area:

The Present study was conducted in Department of Otorhinolaryngology at Index Medical College Hospital & Research Centre, Indore (M.P.)

Study Population:

A prospective study with a sample size of **500** patients was done over a period of 4 months from June 2021 to October 2021 at OPD in Department of ENT.

Inclusion Criteria:

1. Patients of both sexes and aged above 10 years.
2. Patients complaining of decreased hearing.

Exclsion Criteria:

1. Patient aged less than 10 years

Methodology:

Patient attending ENT OPD presenting with complain of decreased hearing will undergo ENT examination. Following this Rinne's tuning fork test will be done to all patients with three tuning forks (256, 512, 1024 Hz). Patient will undergo Pure Tone Audiometry will be performed in a sound-proof room, using MAICO MA 42 audiometer. The results will be obtained, calculated, compared and correlated with an audiometric air-bone gap in PTA and terms of mild, moderate and severe conductive hearing loss.

RINNE TUNING FORK TEST

256 Hz	512 Hz	1024 Hz	DEGREE OF HEARING LOSS	RANGE OF HEARING LOSS
+	+	+	0 – 25 dB	NORMAL
-	+	+	26 – 40 dB	MILD
-	-	+	41 – 70 dB	MODERATE
-	-	-	71 – 90 dB	SEVERE

PURE TONE AUDIOMETRY

RANGE OF HEARING LOSS	DEGREE OF HEARING LOSS
NORMAL	0 -25 dB
MILD	26 – 40 dB
MODERATE	41 – 70 dB
SEVERE	71 – 90 dB

Statistical Analysis:

The data was analysed using SPSS (Statistical Package for Social Sciences) 20.0 version. The descriptive statistics was performed. The correlation between Rinne's method and PTA was analysed using Kappa correlation coefficient. Inter- group comparison was done using Chi-square test. P value <.05 was considered statistically significant.

Observations & Results:

Table No. 1 Age Distribution

		Number of patients	Percentage
Age	11-20	90	18.0
	21-30	140	28.0
	31-40	120	24.0
	41-50	135	27.0
	51-60	5	1.0
	61 or more	10	2.0

The mean age of the study population was 33.77±11.79441 years

Table No. 2 Etiology

	Number of patients	Percentage
Chronic Suppurative Otitis Media	365	73.0
Tympanosclerosis	50	10.0
Traumatic Perforation	20	4.0
Otosclerosis	5	1.0
Acute Suppurative Otitis Media	50	10.0
Adhesive Otitis Media	5	1.0
EAC stenosis	5	1.0

Table No. 3 Comparison Of Detection Of Hearing Loss At Different Frequencies Using Rinne's Tuning Fork Test

			Number of patients	Cochran's Q value	P value
Right side	256 Hz	Positive	365	85.746	<.001*
		Negative	135		
	512 Hz	Positive	170		
		Negative	330		
	1024 Hz	Positive	465		
		Negative	35		
Left side	256 Hz	Positive	215	83.733	<.001*
		Negative	285		
	512 Hz	Positive	195		
		Negative	305		
	1024 Hz	Positive	455		
		Negative	45		

Figure 1 Comparison Of Detection Of Hearing Loss At Different Frequencies Using Rinne's Tuning Fork Test.

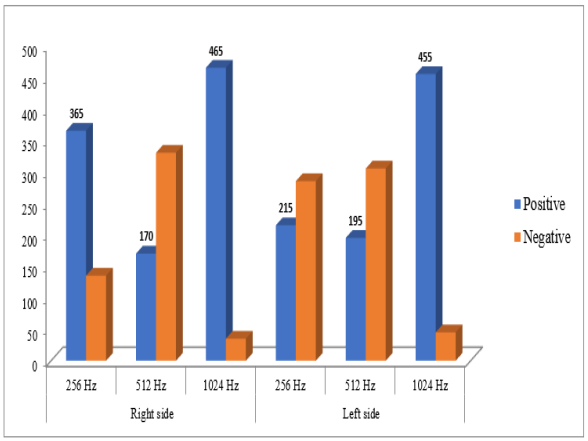
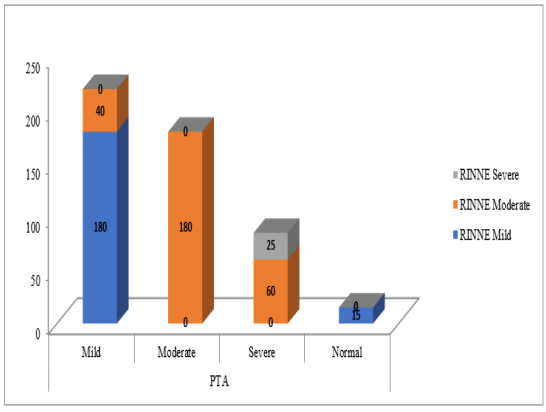


Table No. 4 Correlation Of Hearing Loss Between Diagnosis Made Using Tuning Fork Test And Pta.

		PTA				Total
		Mild	Moderate	Severe	Normal	
RINNE	Mild	180	0	0	15	195
	Moderate	40	180	60	0	280
	Severe	0	0	25	0	25
Total		220	180	85	15	500

Figure No. 2 Correlation Of Hearing Loss Between Diagnosis Made Using Tuning Fork Test And Pta.



According to Rinne's Tuning Fork Test 195 patients were diagnosed to have mild hearing loss whereas according to PTA 180 patients were having mild hearing loss and 15 were diagnose as normal.

There were 180 patients which were diagnosed to have moderate hearing loss according to both the techniques. 40 patients which were diagnosed to have moderate hearing loss by Rinne's Tuning Fork Test were diagnosed to have mild hearing loss according to PTA and 60 patients which were diagnosed to have moderate hearing loss by Rinne's Test were diagnosed to have severe Loss according to PTA.

According to Rinne's method 25 patients were having severe hearing loss, whereas according to PTA 25 patients were having severe hearing loss.

The kappa correlation coefficient value of .628 indicated the substantial agreement between the Rinne's Tuning Fork Test and PTA. This agreement was statistically significant (p value<.05).

DISCUSSION:

The function of the external ear is to direct sounds onto the tympanic membrane. The sound vibrations are then transmitted through the middle ear via the ossicular chain to oval window and then reach 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 present study, Majority of patients were females (61%) and males were (39%).

In study conducted by Shivkumar sennapen et al [9], patients were males (55.0%) and females were (45%).

In present study, the most frequent age was 21 – 30 years and the mean age of the study population was 33.77±11.79 years.

In study conducted by Shivkumar sennapen et al [9], the most frequent age group was 41-50 years (40.7%) and the mean age was 44.5.

In present study, we found that CSOM is the common cause of conductive hearing loss. Similar results were found by other studies.

In study conducted by Kelly et al [10] found that CSOM is the common cause of conductive hearing loss.

In study conducted by Shivkumar sennapen et al [9] found that CSOM is the common cause of conductive hearing loss at a frequency of 72.3%.

In present study, concluded that the results of Tuning Fork Test when compared to audiometry, The kappa correlation coefficient value of .628 indicated the substantial agreement between the Rinne's Test and PTA. This agreement was statistically significant (p value<.05). Results were similar to that of other studies.

In study conducted by Shivkumar sennapen et al [9] they compared the values of Rinne tuning fork test with that of pure tone audiometry values, He 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).

In study conducted by Browning [11], 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.

CONCLUSION:

The present study concluded that Rinne's tuning fork test is a good tool 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. The Tuning Fork Test when compared with Pure Tone Audiometry it was found that there is a substantial agreement between two (p value<.05)., which showed Rinne's Tuning Fork Test as method that is used for screening and will help as aiding tool to quantify degree of hearing loss before the patient is subjected to pure tone audiometry 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, Rinne tuning fork tests is used as reconnaissance tool, and audiometry is a confirmation tool. 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. It can Help Healthcare workers posted at Subcentres, PHCs for hearing assessment.

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