

## THE SIGNIFICANCE OF HUM TEST IN THE DIAGNOSIS OF UNILATERAL HEARING LOSS

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### Abstract

**Background:** Hearing loss affects millions of people worldwide. The need of the hour is to have a reliable test to diagnose hearing loss where prompt treatment is of paramount importance. The hum test is a simple yet effective test which can be incorporated in any given situation. The study aimed to validate the significance of hum test in diagnosing unilateral hearing loss with the objective of comparing sensitivity of hum test to Weber's test using pure tone audiometry (PTA) as the gold standard. **Materials and Methods:** The cross-sectional study included 90 patients of unilateral hearing loss in a rural tertiary care hospital for a duration of 9 months from May 2022 to January 2023. The Weber test, low pitch hum test, high pitch hum test and PTA were performed in the same session and the diagnostic measure of sensitivity was calculated. **Results:** In unilateral hearing loss, the sensitivity of Weber test, low pitch hum test and high pitch hum test in comparison to PTA were 93.3%, 96.7% and 98.9% respectively. In unilateral conductive hearing loss (CHL), the sensitivity of Weber test, low pitch hum test and high pitch hum test were 94.3%, 96.2% and 98.1% respectively. In unilateral sensorineural hearing loss (SNHL), the sensitivity of Weber test, low pitch hum test and high pitch hum test were 91.9%, 97.3% and 100% respectively. In this study, the hum test was more sensitive than the Weber's test and showed a superior ability to diagnose SNHL to the CHL. **Conclusion:** The hum test can be a useful clinical metric to diagnose unilateral hearing loss, more so in sudden hearing loss where urgent care is needed.

## INTRODUCTION

"Blindness cuts us off from things but deafness cuts us off from people" is a quote attributed to Helen Keller who championed the cause of the deaf and blind. Hearing loss affects people of all ages and is the most common sensory deficit in the world. At present, 100 million people in India suffer from significant auditory impairment of which, a larger percentage have unilateral hearing loss.<sup>[1,2]</sup> And by 2050, 2.5 billion people globally are estimated to have some degree of hearing loss with at least 700 million needing hearing rehabilitation for disabling hearing loss.<sup>[3]</sup>

Tuning fork tests are routinely used to evaluate hearing loss as an adjunct to pure tone audiometry (PTA) but may not be accessible at all times. Hence, a reliable test to diagnose audiological emergencies is a pressing priority. Hum test described by Brown in 1995 is a simple test and can be pivotal in

addressing sudden hearing loss in an era of telemedicine where there is a decreased window period for initiating treatment.<sup>[4,5]</sup>

The study aimed to validate the significance of hum test in diagnosing unilateral hearing loss with the objective of comparing sensitivity of hum test to Weber's test using PTA as the gold standard.

## MATERIALS AND METHODS

The cross-sectional study included 90 patients of unilateral hearing loss in a rural tertiary care hospital for a duration of 9 months from May 2022 to January 2023 after obtaining approval from the ethics committee (AIMS/IEC/95/2022). Written informed consent was obtained prior to the study which was performed in consonance with the declaration of Helsinki.

Patients aged between 13-65 years with unilateral hearing loss (CHL/SNHL) were included in the study.

Patients with mixed hearing loss and bilateral ear disease were excluded from the study.

After eliciting a proper history and a thorough examination of the ear, nose and throat, all patients were subjected to 4 tests. The Weber test, low pitch hum test, high pitch hum test and PTA were performed in the same sitting.

For the Weber test, the base of a vibrating 512 Hz tuning fork was placed on the forehead equidistant from both ears for 2-4 seconds. The subject was asked if the sound was perceived in the midline or was louder on one side.

For the hum test, the subject was asked to produce a “mmmmmm” sound for a duration of 2-3 seconds both at high and low tones following the examiner’s demonstration. Whether the sound was perceived in the midline or was louder on one side was duly noted.

The Weber and hum tests work on the same principle. As a ground rule, the sound is normally heard in the centre of the head or equally in both ears. If the hearing is unequal, the test is considered positive for the louder ear.

PTA was done using MAICO MA42 (Maico Diagnostics GmbH) audiometer. Decibel of hearing loss was calculated by taking the average of AC thresholds at 500 Hz, 1 kHz, and 2 kHz as per the Goodman’s classification. An air bone gap (ABG) of >10 dB with normal BC was considered as CHL and those with an average BC threshold of > 25 dB with no significant ABG (< 10 dB) was considered as SNHL.

### Statistical Analysis

The analysis was performed using Statistical Package for Social Sciences (SPSS) version 21.0. Continuous variable was expressed using mean and standard deviation. Categorical variables were summarized as frequencies and percentages. Sensitivity of Weber’s, low pitch hum and high

pitch hum tests were calculated in comparison to PTA.

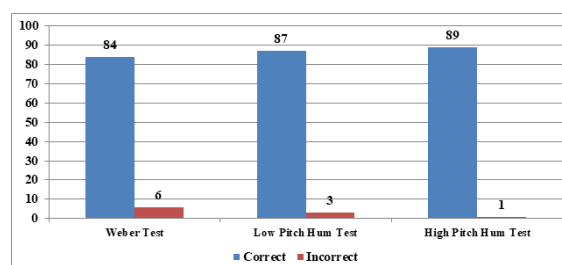
## RESULTS

90 patients between 13-65 years of age enrolled in the study. The mean age was  $37.81 \pm 12.73$  years. 47 (52.2%) were males and 43 (47.8%) were females. [Table 1]

**Table 1: Demographic characteristics of patients**

Variable	Frequency (N=90)
Gender	
Male	47 (52.2%)
Female	43 (47.8%)
Age (Years)	
Mean $\pm$ SD	$37.81 \pm 12.73$

The sensitivity of Weber’s test, low pitch hum test and high pitch hum test in comparison to PTA in unilateral hearing loss were 84 (93.3%), 87 (96.7%) and 89 (98.9%) respectively. [Figure 1]



**Figure 1: Sensitivity of Weber and Hum tests in unilateral hearing loss**

In patients with unilateral CHL, the sensitivity of Weber test, low pitch hum test and high pitch hum test were 94.3%, 96.2% and 98.1% respectively. In patients with unilateral SNHL, the sensitivity of Weber test, low pitch hum test and high pitch hum test were 91.9%, 97.3% and 100% respectively. [Table 2]

**Table 2: Sensitivity of Weber and Hum tests in unilateral CHL and SNHL**

		CHL	SNHL	Unilateral Disease
Weber Test	Correct	50	34	84
	Incorrect	3	3	6
	<b>Sensitivity</b>	<b>94.3</b>	<b>91.9</b>	<b>93.3</b>
Low Pitch Hum Test	Correct	51	36	87
	Incorrect	2	1	3
	<b>Sensitivity</b>	<b>96.2</b>	<b>97.3</b>	<b>96.7</b>
High Pitch Hum Test	Correct	52	37	89
	Incorrect	1	0	1
	<b>Sensitivity</b>	<b>98.1</b>	<b>100</b>	<b>98.9</b>

The hum test was found to be more sensitive than the Weber’s test with the high pitch hum test being superior to the low pitch hum test. In unilateral SNHL, the hum test showed better sensitivity when compared to CHL.

## DISCUSSION

Hearing loss may be mild, moderate, severe, or profound and can be categorized as conductive, sensorineural and mixed (both conductive and sensorineural involvement). The onset can be sudden or gradual. Conductive hearing loss is

secondary to defects in the sound conducting system (external and middle ear). Sensorineural hearing loss occurs when the sound transducing system (cochlea in the inner ear), the auditory nerve, or its central pathways are damaged.<sup>[6]</sup>

Sudden hearing loss (SHL) is defined as a rapid onset, subjective sensation of hearing impairment in one or both ears occurring over a 72 hour period. It can take the form of a sudden sensorineural, conductive or mixed hearing loss.<sup>[7,8]</sup> Sudden sensorineural hearing loss (SSNHL) is defined as a loss of at least 30 dB in 3 contiguous audiometric frequencies within 3 days.<sup>[8]</sup>

The tuning fork invented in 1711 by John Shore, British musician, sergeant trumpeter and lutenist are acoustic resonators which aid in identifying a person's hearing acuity by assessing the air and bone conduction thresholds.<sup>[9]</sup> Air conduction (AC) measures the integrity of the entire hearing apparatus from the external ear to auditory cortex. Bone conduction (BC) measures the integrity of the sensorineural structures from the cochlea to auditory cortex.<sup>[10]</sup>

The Weber test was introduced in 1825 by Ernst Heinrich Weber, a German anatomist and physiologist. It is a simple, rapid and sensitive screening test for detecting unilateral hearing loss which identifies even a difference of 5 dB between the ears.<sup>[4,11]</sup> It is often paired with the Rinne test to detect the site, type and cause of hearing loss. 512 Hz tuning fork is used for the tests as it provides the best balance of time of tone decay and tactile vibration along with lower false positive rates.<sup>[6,12]</sup>

The Weber test is a test of lateralization and works on the basis of the Stenger principle.<sup>[13]</sup> It is perceived as louder in the ear with conductive hearing loss (CHL) and louder in the normal ear in sensorineural hearing loss (SNHL).

In unilateral CHL, sound is lateralized to the affected ear due to the masking and occlusion effects. Masking of the ambient noise results in better perception of sound. Also, occlusion hampers the dissipation of the low frequency sounds in turn leading to increased loudness in the affected ear due to excessive cochlear stimulation.<sup>[14,15]</sup>

In unilateral SNHL, the sound is lateralized to the normal ear which has the better cochlea due to phase differences and intercochlear intensity resulting in louder perception of vibrations.<sup>[16]</sup>

Hum test is elicited by a humming type vocalization and measures a subject's ability to hear comfortably in each ear. A "mmmmmm" sound for a duration of 2-3 seconds both at high and low tones following the examiner's demonstration is performed noting whether the perception of sound is equal in both ears or louder on one side. The test is positive for the louder ear when unequal hearing is reported. Retesting with 2-3 repetitions is recommended to confirm the reproducibility of the response.<sup>[4,17]</sup> It requires no apparatus, takes only few minutes to perform and can be easily incorporated even in online consultations. It is helpful in quickly

assessing common otological conditions with hearing loss and also for immediate post operative evaluation. However, it can be misleading when there is an erroneous assumption or poor cooperation from the subject.<sup>[4,18]</sup>

Pure tone audiometry (PTA) is regarded as the gold standard test for detection of hearing thresholds with an audiometer. The configuration, type and degree of hearing loss across speech frequencies are documented by PTA.<sup>[19]</sup>

The term "sensitivity" is the ability of a test to correctly identify people who have a specific medical condition.<sup>[20]</sup> It has been used frequently in studies pertaining to the Weber test to indicate its ability to show correct lateralization in patients with CHL or SNHL. Its ability to detect unilateral rather than bilateral asymmetrical losses is worth mentioning.<sup>[21]</sup> The median sample size of patients with a specific disease required to calculate sensitivity is 49 and this study with a sample size of 90 met the criteria.<sup>[22]</sup>

In this study, the sensitivity of Weber's, low pitch and high pitch hum tests in unilateral hearing loss were 93.3%, 96.7% and 98.9% respectively. The hum test was more sensitive than the Weber's test and corroborates with the findings of Polson et al.<sup>[23]</sup>

In unilateral CHL, the sensitivity of Weber's, low pitch and high pitch hum tests were 94.3%, 96.2% and 98.1% respectively. In unilateral SNHL, the sensitivity of Weber's, low pitch and high pitch hum tests were 91.9%, 97.3% and 100% respectively. In both the scenarios, the hum test was more sensitive than the Weber's test and the ability of the high pitch hum test was superior to the low pitch hum test in detecting hearing loss. This was similar to the findings of Polson et al.<sup>[23]</sup>

In unilateral SNHL, the hum test showed better sensitivity than the Weber's test. The probable reason being less energy attenuation in the cochlea as the sound is produced by the patient. Also, reduction in cochlear reserve in SNHL patients results in hum with the greater amplitude being heard better. This correlated with the findings of Dhakal et al.<sup>[24]</sup>

The sensitivity of the hum test was better in this study and can be used as a reliable alternative to Weber test in the diagnosis of unilateral hearing loss. It can prove beneficial in bridging the gap between diagnosis and treatment of otological emergencies in this age of telemedicine which will continue to play a vital role in healthcare delivery.<sup>[25]</sup>

## CONCLUSION

Untreated hearing loss can have a devastating impact on peoples' lives. The hum test can be a useful clinical metric to diagnose unilateral hearing loss, all the more in sudden hearing loss where urgent care is vital. Integrating it in the armamentarium of an audiological examination in

the primary healthcare system with evidence-based interventions can help us move towards making ear and hearing care for all a reality bringing to fruition the WHO theme for World Hearing Day on 3rd March, 2023.

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