Dr. Rahul Bagla ENT Textbook
Ultimate Guide – Makes You Best

Assessment of Hearing

Basic Clinical & Tuning Fork Tests for Hearing Assessment

I. Clinical Hearing Tests

Hearing assessments are crucial for diagnosing auditory function and identifying potential hearing impairments. Several clinical tests are employed to evaluate hearing thresholds and sound localisation. The Finger Friction Test, the Watch Test, and the Free Field Voice/Speech Test are among these tests.

i. Finger Friction Test

The **Finger Friction Test** is a simple, qualitative screening tool to assess gross hearing thresholds and sound localisation.

- **Procedure:** The examiner gently snaps their thumb and middle finger together, producing a soft clicking sound. They present this sound near the patient's ear. The patient closes their eyes and indicates when they hear the sound.
- **Interpretation:** This test subjectively evaluates a patient's ability to perceive faint, high-frequency sounds.

ii. Watch Test

Historically, the **Watch Test** was a common method used to estimate auditory sensitivity before audiometers became widely available.

- **Procedure:** The examiner brings a ticking watch close to the patient's ear, gradually moving it closer or further away. The distance at which the patient can reliably hear the ticking sound is noted.
- **Interpretation:** A shorter distance suggests a hearing impairment, whereas a longer distance indicates better auditory sensitivity.

iii. Free Field Voice/Speech Test

The **Free Field Voice/Speech Test** is a structured, yet simple, assessment conducted in a clinical environment. It evaluates hearing in each ear separately.

Procedure:

- **Environment:** Conduct this test in a quiet room to minimise ambient noise interference.
- **Patient Positioning:** The patient stands 6 meters (20 feet) away from the examiner. The examiner faces the test ear, while the patient keeps their eyes closed to prevent visual cues from lip-reading.
- **Masking:** An assistant or the examiner **masks** the non-test ear to prevent sound interference. They achieve this by rubbing an index finger on the patient's tragus or by using a Barany noise box, which delivers a masking noise.
- **Testing:**
- The examiner speaks **spondee words** (e.g., "iceberg," "sunlight," "bathroom") or alphanumeric combinations (e.g., "Y3G," "6BZ") at a **conversational voice level**. The examiner gradually moves closer to the patient until the patient can correctly hear the words. The distance is then recorded.
- Subsequently, the examiner whispers spondee words, and the distance at which the whispered voice is heard is also measured.
- **Interpretation:**
- If a patient can hear a conversational voice from 6 meters, their hearing is likely within normal limits.
- A patient with a hearing loss greater than **30 dB HL** typically **cannot hear a whispered voice from a distance of 2 feet** (approximately 60 cm) from the test ear.
- The test's reported sensitivity is around 95%, with a 10% false-positive rate. Therefore, if a patient can hear a whispered voice from 2 feet away, it suggests their pure tone threshold is better than 30 dB HL.
- **Disadvantages:** Despite its utility, the Free Field Voice/Speech Test has limitations. The standardisation of the intensity and pitch of the voice used during testing is often questioned, and external ambient noise can interfere with the accuracy of results. These factors can affect the reliability of the test outcomes, highlighting the need for careful consideration during clinical assessments.

II. Tuning Fork Tests

Tuning fork tests are quick, inexpensive, and highly valuable clinical tools for differentiating between conductive and sensorineural hearing loss. They are indispensable for ENT residents and MBBS students in the outpatient setting.

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Selection of Tuning Fork. The selection of an appropriate tuning fork is crucial.

- **Frequencies:** Tuning forks are available in various frequencies, including 128 Hz, 256 Hz, 512 Hz, 1024 Hz, 2048 Hz, and 4096 Hz.
- **Clinical Preference:** In clinical practice, a tuning fork of 512 Hz is preferred due to its optimal decay time and minimal overtones, making it ideal for accurate testing.
- **Frequency-Specific Considerations:**
- **Lower frequency forks** (e.g., 128 Hz) tend to produce a tactile sensation of bone vibration, which patients might confuse with sound, thus leading to unreliable results.
- **Higher frequency forks** (e.g., 4096 Hz) have shorter decay times, making them less practical for prolonged testing and prone to rapid sound dissipation, which can also affect test outcomes.

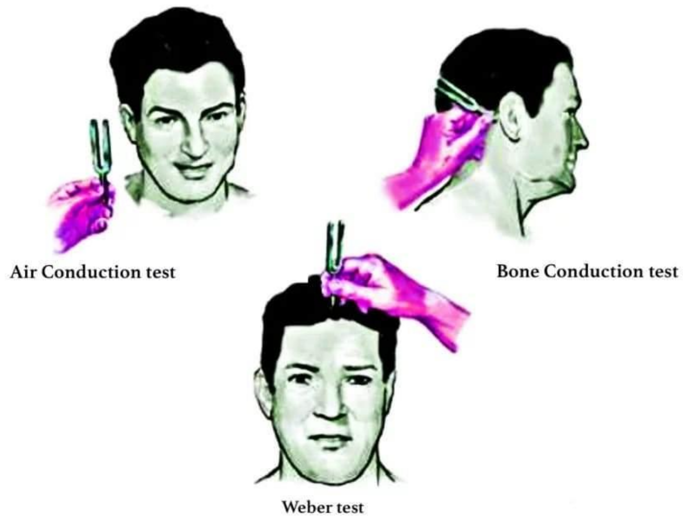
***Setting the tuning fork into vibration*:**

- **Technique:** The practitioner should hold the tuning fork by its stem. Gently strike one of its prongs against a firm yet yielding surface, such as the examiner's elbow or the heel of their hand.
- **Optimal Strike Point:** For optimal results, strike the prong approximately **one-third of its length from the free end**. This technique minimises undesirable overtones and produces a purer tone.

Pre-requisites for tuning fork tests: Before conducting the tests, it is essential to explain the procedure to the patient, instructing them to raise a finger when they can no longer hear the sound. Additionally, the practitioner should stabilise the patient's head to ensure accurate results.

Testing Methods. The tuning fork tests primarily assess two types of conduction: air conduction (AC) and bone conduction (BC).

- **Air Conduction (AC) Test**: The vibrating tuning fork is placed vertically about 2 cm from the external auditory canal. Sound waves travel through the tympanic membrane, middle ear, and ossicles to the inner ear, allowing evaluation of both the conducting mechanism and cochlear function. Typically, sound heard through **air conduction is louder and lasts longer** than through bone conduction.
- **Bone Conduction (BC) Test**: The footplate of the vibrating tuning fork is placed on the mastoid bone. This method bypasses the outer and middle ear and stimulates the cochlea directly through vibrations transmitted via the skull bones, measuring cochlear function alone.



Tuning fork tests

The clinically useful tuning fork tests include:

1. Rinne's Test: In this test, the base of the vibrating tuning fork is placed on the mastoid bone. When the patient can no longer hear the sound, the fork is moved 2.5 cm in front of the external auditory canal. If the patient still hears the sound, it indicates that air conduction is better than the bone conduction.

Interpretation:

- **Positive Rinne**: AC > BC, indicating normal hearing or sensorineural deafness.
- **Negative Rinne**: BC > AC, indicating conductive deafness.
- **False Negative**: In cases of severe unilateral sensorineural hearing loss, the patient may hear the sound on the mastoid but not in front of the ear. This can be confirmed with masking techniques and the Weber test.

The degree of air-bone gap can be assessed using tuning forks of 256, 512, and 1024 Hz, with specific interpretations for each frequency.

- A Rinne test equal or negative for 256 Hz but positive for 512 Hz indicates an air-bone gap of 20–30 dB.
- A Rinne test negative for 256 and 512 Hz but positive for 1024 Hz indicates an air-bone gap of 30–45 dB.
- A Rinne negative for all three tuning forks of 256, 512 and 1024 Hz indicates an air-bone gap of 45–60 dB.

Remember that a negative Rinne for 256, 512 and 1024 Hz indicates a minimum AB gap of 15, 30, and 45 dB, respectively.

2. Weber's Test: This test involves placing the vibrating 512 Hz tuning fork in the middle of the forehead/vertex/ central incisors or mandibular symphysis, from where it will be conducted directly to the cochlea, bypassing the outer and middle ear. The patient is asked to identify which ear they hear the sound better or louder.

Interpretation:

- **Normal Hearing:** The sound is heard equally in both ears and does not lateralize (patient says, "It's in the middle").

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- **Conductive Hearing Loss:** The sound **lateralizes to the affected (poorer) ear**. This happens because:
- **Occlusion Effect:** In a conductive loss, the affected middle ear acts as a barrier, preventing ambient noise from entering the inner ear via the normal air conduction pathway. This makes the bone-conducted sound from the tuning fork relatively louder in the affected ear (autophony).
- **Mass Effect:** A fixed or stiff ossicular chain (e.g., in otosclerosis) or middle ear fluid may enhance bone conduction by impeding sound energy dissipation.
- **Sensorineural Hearing Loss (SNHL):** The sound **lateralizes to the unaffected (better) ear**. In SNHL, the damaged cochlea in the affected ear cannot efficiently process sound, regardless of whether it arrives via air or bone. Therefore, the bone-conducted sound from the tuning fork is better perceived by the healthy cochlea of the unaffected ear.

3. Absolute Bone Conduction Test: This test compares the bone conduction of the patient to that of the examiner, assuming the examiner has normal hearing. Occlude the patient's ear canal (test ear) by firmly pressing the tragus over the meatus (this eliminates air conduction, focusing purely on bone conduction). Place the vibrating 512 Hz tuning fork on the patient's mastoid bone. When the patient reports no longer hearing the sound, immediately transfer the still-vibrating tuning fork to the examiner's own mastoid (with their ear also occluded). The examiner then notes if they can still hear the sound.

Interpretation:

- **Normal or conductive deafness:** Both the patient and the examiner hear the sound for the same duration.
- **Sensorineural deafness:** The examiner continues to hear the sound longer than the patient. This indicates that the patient's bone conduction is reduced compared to a normal ear.

4. Schwabach Test: The procedure is similar to the absolute bone conduction test, but without occluding the ear canal. It also compares the patient's bone conduction to the examiner's.

Interpretation:

- **Normal Hearing:** Patient and examiner hear for similar durations.
- **Conductive Hearing Loss:** Patient hears the sound for a longer duration than the examiner **(lengthened Schwabach)**, due to the occlusion effect and lack of sound dissipation from the middle ear.
- **Sensorineural Hearing Loss:** Patient hears the sound for a shorter duration than the examiner **(shortened Schwabach)**, due to inner ear damage.

5. Bing Test: This test assesses the presence of the **occlusion effect** of the ear canal. Place the vibrating 512 Hz tuning fork on the patient's mastoid process while the examiner alternately closes and opens the ear canal by pressing on the tragus inwards. The patient is asked if the sound changes (gets louder or softer).

Interpretation:

- **Normal Hearing or Sensorineural Hearing Loss:** The sound heard by bone conduction **increases (gets louder)** when the ear canal is blocked **(Bing positive)**. This is due to the **occlusion effect**, where blocking the ear canal prevents sound energy from escaping, thus enhancing bone-conducted sound perception.
- **Conductive Hearing Loss:** There is **no significant change** in sound perception when the ear canal is blocked **(Bing negative)**. This is because the conductive pathology (e.g., fixed or disconnected ossicular chain, middle ear fluid) already prevents sound dissipation, so further blocking the ear canal offers no additional "occlusion."

6. Gelle's Test: This test assesses the functional status of the **ossicular chain** by altering air pressure in the external auditory canal. Normally, when air pressure is increased in the ear canal by Siegel's speculum, it pushes the tympanic membrane and ossicles inwards, raises the intralabyrinthine pressure and causes immobility of the basilar membrane and decreased hearing, but no change in hearing is observed when the ossicular chain is fixed or disconnected. Place the vibrating 512 Hz tuning fork on the patient's mastoid process while altering air pressure in the ear canal by pneumatic otoscope or impedance probe. Ask the patient if the loudness of the sound changes.

Interpretation:

- **Normal Subjects:** With increased air pressure (pushing the tympanic membrane inward), the loudness **increases.** This happens because the ossicular chain is stiffened by the pressure change, reducing the transmission of bone-conducted sound.
- **Conductive Hearing Loss (Ossicular Fixation/Discontinuity):** Patients show **no change** in sound perception. If the ossicular chain is already fixed (e.g., otosclerosis) or discontinuous, changes in external ear canal pressure will not affect its mobility or the transmission of sound to the inner ear.

Special Tuning Fork Tests for Malingering and Non-Organic Deafness

1. Stenger's Test. Stenger's test is based on the principle that when two identical sounds are presented to a person with one healthy ear and one deaf ear, the individual will only perceive the sound in the ear that is closer to the sound source.

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Procedure: In this test, the patient is blindfolded. The examiner uses two similar tuning forks, typically of 512 Hz, struck to moderate intensity and held approximately 25 cm from each ear. If the patient is malingering, he will only hear the sound in the normal ear. The tuning fork on the deaf side is then moved closer by 3 inches. A malingerer will not perceive the sound at all, confirming the suspicion of non-organic deafness.

2. Chimani Moos Test. The Chimani Moos test is a modification of the Weber test, designed to identify non-organic hearing loss.

Procedure: When a vibrating tuning fork is placed on the forehead, a malingerer will often report hearing the sound in their better ear, which simulates sensorineural deafness. If the ear canal of the better ear is occluded, a genuinely deaf patient will still hear the sound in the occluded ear, while a malingerer will claim they cannot hear it.

3. Teal Test. The Teal test specifically evaluates the validity of claims where patients assert they can only hear through bone conduction (a pattern highly suspicious of non-organic hearing loss, as pure bone conduction hearing without any air conduction is rare).

Procedure: This test involves presenting a vibrating tuning fork to the mastoid and then alternately to the external ear canal while the patient's ear is occluded and unoccluded. A malingerer will typically maintain that they only hear the sound via bone conduction, even when conditions are optimal for air conduction.

Voice Tests for Malingering and Non-Organic Deafness

1. Erhard's Test. Erhard's test is utilised to detect total unilateral hearing loss. In this procedure, the ear canal of the normal ear is occluded, which reduces speech perception by 30 dB or less. The suspected malingerer is instructed to close their eyes and repeat words they hear. The examiner occludes the normal ear by pressing on the tragus and then speaks words into the suspected ear. If the patient fails to repeat the words, it suggests malingering, as even with the head shadow effect, the other ear should still be able to hear.

2. Lombard's Test. Lombard's test is grounded in the observation that individuals typically raise their voice when speaking in noisy environments. During this test, the patient is asked to read prose aloud. Noise is then introduced to the good ear. If there is an organic loss in the suspected ear, the patient will raise their voice. Conversely, if the hearing loss is feigned, the patient will show no change in speech volume, indicating normal monitoring of their voice.

Table: Tuning fork tests and their interpretation

Test	Normal	Conductive deafness	SN deafness
Rinne	AC > BC (Rinne positive)	BC > AC (Rinne negative)	AC>BC
Weber	Not lateralized	Lateralizes to the poorer ear	Lateralizes to the better ear
ABC	Same as the examiner's	Same as the examiner's	Reduced (patient hears less)
Schwabach	Equal	Lengthened (patient hears longer)	Shortened (patient hears shorter)
Bing	Positive (sound increases with occlusion)	Negative (no change with occlusion)	Positive (sound increases with occlusion)
Gelle's	Sound increases with a pressure change	No change with pressure change	Sound increases with a pressure change

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