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An Overview on Clinical Assessment of Tinnitus

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Abstract:

Tinnitus is a common auditory symptom that may arise from various otologic, neurological, vascular, or systemic conditions, often associated with multiple comorbidities. Its diagnosis is primarily subjective and depends on patient self-report, necessitating a comprehensive and multidisciplinary assessment approach. Clinical evaluation includes detailed history taking, self-assessment using validated questionnaires, physical examination, and audiological evaluation. Advanced diagnostic tools such as imaging studies may be required to identify underlying causes and guide appropriate management.

Keywords: Tinnitus, Clinical assessment, Audiological evaluation, Otoacoustic emissions, Tinnitus questionnaires, Objective tinnitus, Subjective tinnitus, QOL, Morbidity.

Introduction:

Tinnitus is defined as the auditory perception in the head and/or ears in the absence of external acoustical stimulus **(1).** The term is derived from the Latin word tinnire, which means "to ring" **(2).** Patients often describe tinnitus as a ringing, buzzing, whistling, hissing, or pulsatile sound in the ears and/or head and can be continuous or intermittent **(3).** Tinnitus can result from a variety of underlying conditions and is often associated with numerous comorbidities, highlighting the importance of multidisciplinary diagnostic approach (**4).**

The impact of tinnitus on patients' daily lives is complex and largely determined by associated psychological experiences **(5).** Therefore, it is crucial to distinguish between the "tinnitus sound" as an initial tonal symptom and "tinnitus-related distress" as a multi-layered psychological phenomenon **(6).** Researchers suggest that reactive tinnitus-related distress is particularly important as it can significantly facilitate chronification of the often harmless initial symptomatology **(5, 7).**

Tinnitus-related distress arises against a background of pre-existing medical, psychological or social vulnerability and can manifest itself in a variety of functional phenomena, such as anxiety and depression cycles, sleep or concentration difficulties and cognitive difficulties **(8).**

The initial diagnosis of tinnitus should involve taking a detailed medical history, evaluating the severity of tinnitus, conducting a clinical ear examination, and performing audiological tests to assess hearing function. Advanced diagnostic procedures may be necessary if basic evaluations indicate acute onset or suggest a serious underlying condition, in order to better understand the pathophysiology and progression of tinnitus **(9).**

History taking

Before diagnosis, the general patient history collection including demographic data such as age, gender, education level, and family history makes senses. Then, a specialized and detailed tinnitus inquisition is quite essential **(9).**

The self-reported perceptive position, tinnitus duration, and sound properties of pitch and loudness, particularly whether it has a rhythmical or pulsatile component, are the main concerns. Besides, tinnitus-relevant factors such as noise exposure, sudden hearing loss, presbycusis, traumatic deafness, ototoxic drug application, and so on should also be identified. The diseases originated from ears, and some tinnitus-relevant chronic

systematic diseases such as hypertension, diabetes, coronary heart disease, and especially neurological disorders should also be figured out **(6).**

There are other health disorders frequently associated with tinnitus, such as neck or TMJ disorders, vertigo, insomnia, headache, anxiety or depression. These comorbidities may be a cause or a consequence of tinnitus. In all cases, the co-occurrence of these disorders is of relevance for the therapeutic management. Irrespective of whether there is a causal relationship or not, successful treatment of tinnitus co-morbidities can improve the patient's quality of life enormously **(4).**

Self assessment questionnaires

Tinnitus severity can be assessed either by scales or by validated questionnaires. Tinnitus grading according to **Biesinger et al. (10)** concluded 4 grades. Grade I: Tinnitus is well compensated without psychological strain, Grade II: Tinnitus appears only in silence and is disturbing during periods of stress and pressure, Grade III: Tinnitus interferes continuously in private and professional areas, Grade IV: Tinnitus leads to complete decompensation in the private area and disability. Patients with grades III and IV or high scores (more than 37 in tinnitus handicap inventory) should be examined with a focus on signs of depression or anxiety **(11).**

There are several validated questionnaires available to assess the influence of tinnitus on a patient's life. It usually provides information that can help in determining appropriate management and evaluate tinnitus progress **(12).** Among the most commonly used questionnaires is the Tinnitus Handicap Inventory (THI) which is a 25-item self-report questionnaire, firstly introduced by **Newman et al. (13)**. Its scores are on a three-label category scale (0, 1, 2 scores) and assesses the severity of tinnitus on three domains: functional, emotional, and catastrophic. The total score of global tinnitus distress and impact ranges from 0 to 100 points, and guidelines for classification of tinnitus severity constitute no handicap (0–16), mild handicap (18–36), moderate handicap (38–56) or severe handicap (58–100) **(9).**

Likewise, the Tinnitus Handicap Questionnaire (THQ) which was intended to measure patients' perceived degree of handicap due to tinnitus. It has three domains: physical, emotional and social consequences, hearing ability ,and personal viewpoint on tinnitus. Seven items specifically address the interference of the tinnitus on daily activities; four of which address hearing difficulties, two items address social interactions and one item addresses sleep difficulties because of the tinnitus **(14).**

Another commonly used questionnaire is the Tinnitus Questionnaires (TQ) which assesses tinnitus-distress across six domains: emotional distress, cognitive distress, intrusiveness, auditory and perceptual **(15).** Similarly, the Tinnitus Reaction Questionnaire (TRQ) was also developed to measure distress related to tinnitus. It has four sub-scales: general distress, interference, severity, and avoidance of tinnitus **(16).** Moreover, the Tinnitus Severity Index (TSI) which was introduced as a measure of how much tinnitus negatively impacts a patient's life and how bothersome patients perceive their tinnitus to be. Two items specifically measure how much tinnitus interferes with daily life activities **(17).**

Additionally, the Tinnitus Severity Questionnaire (TSQ) which is a short and unified measure with two items specifically addressing the interference of the tinnitus, one item on sleeping habits and one on impairment of concentration **(18).** More recently, the Tinnitus Functional Index (TFI) which was developed as a new measure of the severity and negative impact of tinnitus. The questionnaire is a multi-domain questionnaire, measuring tinnitus-related psychological constructs, such as attention, worry, anxiety, depression as well as the more functional constructs such as hearing, social life and activity level **(19).**

Furthermore, Questionnaire for Tinnitus Reaction in the Arabic Language in Adults with Normal Hearing (Arabic-QTR) which is a 18-item scale developed to assess the severity and impact of tinnitus in adults with chronic subjective tinnitus and normal hearing. It has four subscales: somatic effect, awareness, emotional effect, and anxiety **(20).**

There are also several questionnaires that have been translated and validated into arabic. These include the arabic version of THI, which has three sub-scales: functional, emotional and catastrophic responses to tinnitus, assesses the impact of tinnitus on the quality of life **(21).**

The arabic version of the Hospital Anxiety and Depression Scale (HADS) is a 14-item scale with two sub-scales: anxiety and depression **(22).** The arabic version of the Patient Health Questionnaire (PHQ-9) is a 9-item scale measuring depressive symptoms corresponding to diagnostic criteria for depression in the DSM-IV **(23).** Additionally, the arabic version of the Generalized Anxiety Disorder (GAD-7) is a 7-item instrument designed to assess anxiety over the past two weeks and strongly associated with multiple domains of functional impairment and disability days **(24).**

Sleep quality can also be assessed using arabic version of the Pittsburgh Sleep Quality Index (PSQI) which is a 19-item scale with the following domains: sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication and daytime dysfunction **(25).**

Physical examination

Physical examination of a tinnitus patient begins with a comprehensive assessment of the head, neck, and auditory system to identify potential causes or contributing factors. The examination focuses on difference between objective tinnitus and subjective tinnitus **(26).**

Objective tinnitus can be heard as a sound outside the ear and therefore can be detected by an observer using a stethoscope or ear canal microphone. It usually has a pulsatile quality, and should be confirmed whether it is synchronous with the pulse through the auscultation of the neck and head region in quiet environment **(12).**

It can be divided into arterial or venous origins. The procedures in order to distinguish between arterial and venous tinnitus are very important. For example, one can apply gentle digital pressure to the ipsilateral internal jugular vein. Resolution of the tinnitus implies a venous source, whereas persistence of the tinnitus implies an arterial source. Vascular stenosis, aneurysms or anatomical variants of arteries are arterial major causes, while intracranial hypertension, venous malformation or anatomical variation are venous major causes **(12, 27).**

Therefore, if a patient is suspected of having objective tinnitus, additional diagnostic imaging including Magnetic resonance angiography (MRA) is useful in imaging arteries that supply the brain. CT angiography also can be useful for evaluating the veins and sinuses **(12).**

In contrast, subjective tinnitus is more frequent and can only be perceived by the patient; thus, diagnosis of it mainly relies on patients' self-report. Otologic disorders are the most common cause of it, with many causes stemming from the underlying conditions associated with hearing loss **(28, 29).**

Therefore, otoscopic examination should be performed to provide direct visualization of the external ear canal and tympanic membrane. Obstructions, such as cerumen impaction or foreign bodies, can cause tinnitus through conductive hearing loss. Also the tympanic membrane is inspected for abnormalities like perforations, middle ear effusion, or signs of infection. Chronic otitis media, cholesteatoma, and eustachian tube dysfunction are conditions commonly associated with tinnitus and may be evident during this examination. Identifying any visible abnormalities in this region is vital as they might point toward treatable causes **(30, 31, 32).**

Furthermore, vital signs, such as blood pressure and pulse, are crucial to detect systemic factors like hypertension, which may exacerbate tinnitus. The examiner should evaluate posture, signs of head or neck trauma, and vascular anomalies such as carotid artery bruits that may contribute to tinnitus. This step ensures that systemic or anatomical abnormalities linked to tinnitus are not overlooked **(26).**

A neurological examination is also essential to assess the cranial nerves, especially cranial nerve VIII (vestibulocochlear nerve). Dysfunction of this nerve may indicate a retrocochlear lesion, such as a vestibular schwannoma, which can present with unilateral tinnitus and hearing loss. The examination also includes assessing cranial nerves V and VII, as abnormalities may suggest conditions like neurovascular compression syndromes or brainstem pathologies. Evaluating balance, gait, and coordination can help identify associated vestibular disorders, which may be a contributing factor in tinnitus patients **(33, 34, 35).**

Additionally, musculoskeletal factors such as temporomandibular joint (TMJ) dysfunction or cervical spine abnormalities can contribute to somatic tinnitus. Therefore, palpation of the TMJ and cervical spine, as well as

observing jaw movements, can identify tenderness, clicking, or restricted movement indicative of somatic contributions to tinnitus. This comprehensive assessment ensures that structural and vascular etiologies are considered in the diagnostic process **(36, 37, 38).**

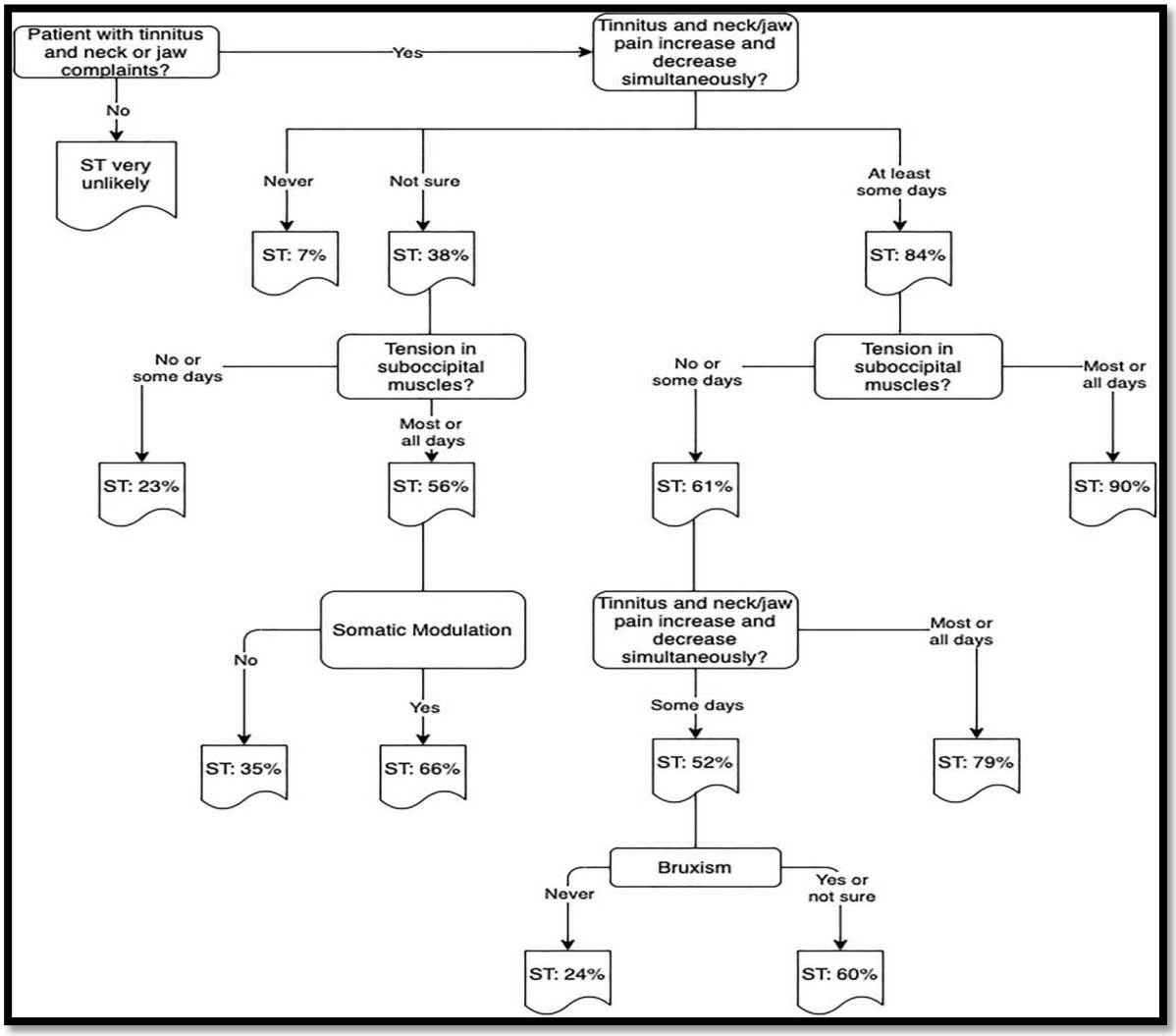
Somatosensory tinnitus assessment

Since the first studies in the 1990s mentioned the possible influence of the somatosensory system on tinnitus complaints **(39, 40, 41)),** several papers have described ways to identify these patients. **Sanchez et al. (38).** proposed a set of diagnostic criteria to help recognize patients with somatosensory tinnitus in clinical practice. These criteria include the presence of recurrent pain episodes in the head, neck, or shoulder girdle and a temporal coincidence of the appearance of both tinnitus and pain complaints **(42, 43).**

Furthermore, **Michiels et al. (44)** constructed a decision tree for somatosensory tinnitus diagnosis. The decision tree includes four criteria: tinnitus and neck/jaw pain increase/decrease simultaneously, tension in suboccipital muscles, somatic modulation, and bruxism as shown in **Figure (1).**

However, the complexity of somatosensory tinnitus requires that patients with this disorder to be evaluated by an integrated team including an experienced dentist and physiotherapist to evaluate possible bone and muscular disorders of the face and neck as well as dental problems **(45).**

Figure (1): Rapid screening for somatosensory tinnitus tool. Quoted from **Michiels et al. (45).**



Audiological assessment

Audiological evaluation can determine the natures of the patient's tinnitus and lesion site. It includes pure tone audiometry, speech audiometry, tympanometry, videonystagmography (VNG), auditory brainstem response (ABR), acoustic reflex, decay examination and otoacoustic emissions (OAEs) which can be either spontaneous or evoked by sounds **(12, 46).**

These audiological evaluations will help to distinguish between sensory and conductive hearing loss, and identify the retro-cochlear origin. Extended high-frequency audiometry can also be used in cases of tinnitus with normal hearing. The acoustic reflexes, decay examination and ABR will demonstrate whether a lesion is on the eighth nerve. VNG will also help identify disorders such as Meniere's disease or secondary endolymphatic hydrops **(12, 30).**

Several studies have attempted to reveal the relation between tinnitus and OAEs **(47, 48, 49).** Evidence indicates that subtle changes in cochlear function can be detected by OAEs testing even before the occurrence of significant changes in the patient's audiogram. If the OHCs are to be involved in the generation of tinnitus, testing of OAEs could provide a reliable means of recording OHCs dysfunction (**46).**

While changes in TEOAEs during contralateral acoustic stimulation could provide a measure of medial olivocochlear bundle (MOC) strength **(50).** Several studies have also demonstrated an association between abnormal olivocochlear efferent function and tinnitus. Impaired OCB activity can lead to reduced inhibitory feedback, resulting in heightened auditory nerve responses and the perception of phantom sounds **(51, 52, 53).**

Tinnitogram (psycoacoustical assessment)

Distribution of tinnitus quality depends on the patient's own report which may be fraught with problems. For example, different individuals exhibit different acoustic experiences and hence may not use the same word to describe their tinnitus **(54).**

Therefore, psychoacoustic measures of tinnitus have sometimes been used as part of a comprehensive assessment of the experience of tinnitus alongside otoscopy and pure tone audiometry. Psychoacoustic measures commonly include tinnitus pitch and loudness matching, minimal masking levels and residual inhibition. They have been used to form a baseline measure against which to monitor the success of the management plan **(55).**

Pitch matching specifically has been used to establish the frequency characteristics of tinnitus to use it as a reference point for fitting of tinnitus maskers, and then adjusted in intensity to match the loudness of the tinnitus to be quantified in terms of decibels (dB). While minimal masking levels have been used as the lowest level at which the tinnitus can be masked by a stimulus, often narrow band noise, broad band noise or a pure tone. Finally, residual inhibition which is a phenomenon whereby tinnitus is temporarily reduced after the presentation of masking noise for a short period of time, determining whether the tinnitus masking would be an applicable management course **(12, 55).**

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