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Review

Tinnitus Assessment

Chul Won Yang, Jae Yong Byun

Department of Otorhinolaryngology, Head and Neck Surgery, School of Medicine, Kyung Hee University, Seoul, Korea

Tinnitus is a common medical condition where patients perceive unwanted noise in the absence of environmental stimuli. However, it is very difficult to find out definite causes of each patient's tinnitus. According to tinnitus classification systems, there are many different diagnostic tools. Representatively, tinnitus can be divided into objective and subjective tinnitus. Also, there are many etiologic factors for each classified tinnitus. Tinnitus assessment is defined as finding out the exact cause of tinnitus and prediction of treatment effect. It starts from history taking and physical examination to audiologic evaluations. Also, it is an important part in the relationship with the patient, as well as tinnitus objectification in the treatment process. And, it affects the consequent management of tinnitus. Otherwise, assessment of tinnitus is a challenging task due its subjective nature. Therefore, a multidimensional diagnostic approach to tinnitus is very important in appropriate treatment of tinnitus and in predicting the effect of the management.

Key Words: Tinnitus; Assessment; Evaluation; Etiology; Treatment

Correspondence to: Jae Yong Byun
Department of Otorhinolaryngology, Head and Neck Surgery, School of Medicine, Kyung Hee University, 892 Dongnam-ro, Gangdong-gu, Seoul 05278, Korea
Tel: +82-2-440-6857
Fax: +82-2-440-7336
E-mail: otorhino512@naver.com

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INTRODUCTION

Tinnitus is the unwanted auditory perception of sound without an environmental sound source [1]. The prevalence of tinnitus estimated from 4% to as high as 32%. The severity of tinnitus varies from an occasional awareness of a noise to an unbearable sound that drives some individuals to contemplate suicide. For most patients, chronic tinnitus is not serious enough to cause them to seek treatment [2-5]. However, about 2% of tinnitus patients experience significant debilitating problems. Tinnitus sufferers often have difficulty falling asleep, and experience depression, annoyance, and confusion. The patient with tinnitus wants to quantify the subjective symptom[1]. Tinnitus is a symptom, not a disease, with many different causes. Also, tinnitus has different classification systems. This makes the determination of appropriate therapy difficult. Assessment of tinnitus is a challenging task due its subjective nature. In addition, appropriate treatment modalities should be chosen according to the different causes of tinnitus. Therefore, the present study examines the purpose of tinnitus evaluation and how clinicians can best employ different evaluation methods.

THE PURPOSE OF THE TINNITUS EVALUATION

Reassurance and effective counseling between the clinician and patient is very important during the process of evaluation. Tinnitus evaluation enables patients to communicate symptoms to clinicians. It also offers an objective picture of the tinnitus rather than solely relying on a subjective description of the sound or sounds a patient is hearing. However, it may help otologists determine whether its origin is vascular (rhythm) or middle ear (clicking). The presence of the tinnitus makes patients feel insecure, because unaffected people cannot hear the sounds of tinnitus. The form of tinnitus that a patient is experiencing and a patient's family characteristics and history can be determined by tinnitus assessment [6,7]. Tinnitus assessment enables clinicians to determine treatment timing and offer diagnosis guidelines to patients. In addition, it helps to predict whether treatment will be effective and provide treatment guidelines. Otologists can set the level and extent of the sound therapy's stimulation through measurement of the masking ability or pitch matching and also determine the site of origin of the tinnitus. First, tinnitus is generally classified as objective or subjective in classifying the tinnitus. Also, it divided into vibratory

and non-vibratory type. So, assessment can determine whether the client may benefit from different types of treatment. Also, patients can have different reactions when listening to the same acoustic stimulus. Documentations about the tinnitus through the questionnaire can be useful to identify the patient symptom severity. Finally, documenting the presence of tinnitus can be useful in situations that require documentation for legal reasons. The presence of tinnitus may need to be validated with regard to the degree of impairment, disability and/or handicap [8-10].

DIAGNOSTIC ASSESSMENT OF THE TINNITUS

1. History & physical examination

The assessment of tinnitus patient begins with the collection of tinnitus history and physical examination in order to distinguish between objective and subjective tinnitus. Patient history includes onset, location (tinnitus site), pattern, characteristics and associated symptoms such as hearing loss, vertigo, hyperacusis, previous tinnitus testing, illnesses and medications. In addition, general medical exams (screening for cardiovascular, endocrine, renal, and metabolic problems) should be performed.

During physical examination, an otologic examination should be performed to confirm the presence of infection, impacted cerumen and so on through inspection of external auditory canal and the tympanic membrane. Also, a cranial nerve functional test should be performed for examination of brainstem damage. Auscultation over periauricular region should be performed to determine the pulsatile vascular origin of objective tinnitus. Finally, a simple C2 or C3 tuning fork test can be performed for the evaluation of sensorineural or conductive hearing loss through the Weber and Rinne tests.

2. Objective tinnitus and subjective tinnitus

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. Objective tinnitus arises from vascular or muscular sources. As mentioned above, objective tinnitus classified to vibratory or pulsatile tinnitus. Objective tinnitus usually has a pulsatile quality [1,7]. First, objective tinnitus should be confirmed whether it is synchronous with the pulse through the auscultation of the neck and head region in quiet environment. 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, verification whether the tinnitus is disappeared during vascular compression test or neck rotation maneuvers can be useful. Vascular stenosis, aneurysms, anatomical variants of arteries are representative arterial major causes. And, intracranial hypertension, venous malformation or anatomical variation are venous major causes. Therefore, if a patient is suspected of having objective tinnitus, additional diagnostic imaging including brain computed tomography (CT) or magnetic resonance imaging (MRI) should be performed. 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.

Subjective tinnitus involves sounds that only the patient can sense and are not audible. The precise mechanisms of subjective tinnitus are still not definitely revealed and many possible causes have been reported. Tinnitus research has revealed mechanisms likely responsible for some forms of idiopathic tinnitus. And otologic disorders are the most common causes of idiopathic tinnitus. According to etiology, associated hearing loss, psychoacoustic features, exacerbating factors, psychological comorbidities, and the presence of somatic modulators can be subtyped [11]. Representative diagnostic testing of subjective tinnitus is classified as follows.

3. Audiologic evaluation

Audiologic evaluation can assist with determining the natures of the patient's tinnitus and lesion site. Audiologic evaluation is consisted of basic audiometric tests: pure tone audiometry, speech audiometry, tympanometry, electrocochleography (EcoG), Electronystagmography (ENG), auditory brainstem response (ABR), Acoustic reflex and decay examination. These audiologic evaluations will help to distinguish between sensory and conductive hearing loss, and identify the retro-cochlear origin. The acoustic reflexes and decay examination and the ABR will demonstrate whether a lesion is on the eighth nerve. ENG will also help identify disorders such as Meniere's disease or secondary endolymphatic hydrops.

4. Tinnitogram (psychoacoustical measurements)

Psychoacoustic measurements allow a tester to identify and quantify subjective tinnitus [10,12]. Psychoacoustical measurements are divided into a pitch-match test, loudness-match test, residual inhibition and masking.

The purpose of the pitch matching test is to quantify tinnitus by the medium of possible frequency. It is used as a reference point

for fitting of tinnitus maskers. The pitch matching procedure is usually a two-alternative forced choice. The patients hear two tones and must choose the tone that is closest to what they hear (tinnitus). Until the correct match is chosen, this process is repeated seven to nine times. When a pitch matching test is performed, confirmation of the results with an octave confusion test it is recommended, as octave confusion can be generated when identifying a specific frequency as the pitch match of the tinnitus [13-16]. The purpose of the loudness-match test is detection of sound intensity. This test can quantify tinnitus in terms of decibels (dB). Matching sounds start at a level below threshold and increase in intensity until the patient expresses a synchronization. The two-alternative forced-choice method can be substituted for the ascending limits method, because the effect of residual inhibition can be reduced. The test frequency is the same as for pitch matching [17-22]. The residual inhibition test is used for determining whether the tinnitus masking would be an applicable management course. The test is defined as the suppression of tinnitus during masking. Clinicians should use a tinnitus frequency at 10 dB above the loudness match for one minute. The post-masking effect is divided into four categories: 1) Positive: complete absence for more than one minute, 2) Positive-partial: Lowered level of tinnitus for more than one minute, 3) No change in tinnitus, and 4) Rebound: Louder after masking. The masking test is important for predicting whether the sound generator can control the tinnitus. Patients hear a low level noise band or tone for 2-3 seconds and check whether they can hear their own tinnitus. The level is altered until the tinnitus is masked. The results of the curves are classified into six types using Fieldman's system.

5. Questionnaire assessment

The purpose of a tinnitus questionnaire is to assess the influence of tinnitus on a patient's life. It provides information that can help determine appropriate treatment and evaluate tinnitus progress. Commonly used questionnaires are Tinnitus Handicap Inventory (THI), Tinnitus and Hearing Survey (THS), and Tinnitus Functional Index (TFI). The THI is comprised of 25 items with yes or no answers. It contains items relating to functional, emotional, and catastrophic reactions to tinnitus. The results of the THI form a handicap severity score ranging from mild to severe. Through the THI score, otologists can determine appropriate treatment approaches and determine whether patients may need further medical and psychoacoustic evaluation [23-25]. The THS is not a primary results measure, but is used as a supplementary questionnaire. The THS is comprised of 10 items (4 items on tinnitus issues; 4 items on common hearing problems; and 2 items on questions concerning sound tolerance). Patients respond using a 5-point Likert scale ranging from 1 (indicating no problems) to 5 (indicating great difficulty). The THS is most useful to tinnitus patients with co-existing hearing loss, because the THS helps to define the border of these issues. Finally, the TFI consists of 25 items. The components of the TFI include eight subscales addressing interference, auditory problems, sense of control, cognitive effects, sleep disturbances, officiousness with relief, quality of life, and emotional pain. Patients respond using a 10-point scale, with an overall score ranging from 0-100 [26,27].

CONCLUSION

There has been considerable research on and recognition of the seriousness of tinnitus over the last decade. Hearing evaluation instruments have been developed to provide solutions for tinnitus management. However, many etiologic factors and mechanisms affect the consequent management of tinnitus. Informing patients of evaluation plans and treatment options is an important step in the management of tinnitus. Therefore, assessment is crucial for the classification and determination of appropriate treatments for tinnitus.

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REFERENCES

1. Carol AB. Cummings Otolaryngology: Head & Neck Surgery. 6th ed. Philadelphia: SAUNDERS; 2015:2336-43.
2. Lokenberg R. Evaluation and treatment of tinnitus. Graduate Theses and Dissertations 2000:3-14.
3. Tyler RS, Aran JM, Dauman R. Recent advances in tinnitus. Journal of the American Academy of Audiology 1992;1(4):36-44.
4. Jastreboff PJ. Instrumentation and tinnitus: a neurophysiological approach. Hearing Instruments 1994;45:7-31.

5. Shulman A, Aran J, Tonndorf J, Feldmann, H, Vernon JA. (Eds.) Tinnitus: Diagnosis/Treatment. San Diego: Singular Publishing Group, Inc. 1997;253-92.
6. Wendy S, Au D, Clement S, Aud M. Tinnitus Assessment: the key to successful tinnitus patient management. The Hearing Review. 2014.
7. Goldstein B, Shulman A. Tinnitus Classification: Medical Audiologic Assessment. In: Tinnitus, Proceedings of the First Tinnitus Seminar. J Laryngol Otol Suppl 1981;4:33-8.
8. Stouffer JL, Tyler RS. Characterization of tinnitus by tinnitus patients. Journal of Speech and Hearing Disorders 1990;55:439-53.
9. Douek E, Reid J. The diagnostic value of tinnitus pitch. J Laryngol Otol 1968; 82(11):1039-42.
10. Holgers K, Barrenas M, Svedlund J, Zoger S. Clinical Evaluation of Tinnitus: a Review. Audiological Medicine 2003;1:2101-6.
11. Pichora-Fuller MK, Santaquida P, Hammill A, Oremus M, Westerberg B, Ali U, et al. Evidence-based Practice Center Systematic Review Protocol Project Title: Evaluation and Treatment of Tinnitus: A Comparative Effectiveness. Comparative. 2013.
12. Fortune DS, Haynes DS, Hall JW. Tinnitus; Current evaluation and management. Med Clin of North Am 1999;83:153-62.
13. Goldstein B, Shulman A. Tinnitus evaluation. Tinnitus: diagnosis/treatment. San Diego: Singular Publishing Group, Inc. 1997;293-318.
14. Henry JA, Meikle MB. Psychoacoustic measures of tinnitus. Journal of the American Academy of Audiology 2000;11(3):138-55.
15. Tyler RS, Conrad-Armes D. Tinnitus pitch: a comparison of three measurement methods. British Journal of Audiology 1983;17:101-7.
16. Vernon JA. The loudness of tinnitus. Hear Speech Action 1976;44:1719-21.
17. Vernon JA, Fenwick J. Tinnitus "Loudness" as Indicated by Masking Levels With Environmental Sounds. In: Proceedings, Second Int. Tinnitus Seminar. J Laryngol Otol 1984;9:59-62.
18. Mitchell C. The masking of tinnitus with pure tones. Audiology 1983; 22:73-87.
19. Feldmann H. Homolateral and contralateral masking of tinnitus by noisebands and by pure tones. Audiology 1971;10:138-44.
20. Vernon JA, Schleuning AJ. Tinnitus: a new management. Laryngoscope 1978;85:413-9.
21. Feldmann H. Tinnitus masking curves: updates and review. In: Proceedings of the Second International Tinnitus Seminar. J Laryngol Otol Suppl 1984;9:157-60.
22. Mitchell CR, Vernon JA, Creedon TA. Measuring Tinnitus Parameters: loudness, pitch, and maskability. J Am Acad Audiol 1993; 4:139-51.
23. Newman CW, Jacobson GP, Spitzer JB. Development of the Tinnitus Handicap Inventory. Archives of Otolaryngology 1996;122:143-8.
24. Newman CW, Sandridge SA, Jacobson GP. Psychometric adequacy of the Tinnitus Handicap Inventory (THI) for evaluating treatment outcome. Journal of the American Academy of Audiology 1998;9:153-60.
25. Figueiredo RR, Azevedo AA, Oliveira PM. Correlation analysis of the visual-analogue scale and the Tinnitus Handicap Inventory in tinnitus patients. Revista Brasileira de Otorhinolaringologia 2009;75:76-9.
26. Meikle MB, Henry JA, Griest SE, Stewart BJ, Abrams HB, McArdle R, et al. The tinnitus functional index: development of a new clinical measure for chronic, intrusive tinnitus. Ear Hear March-April 2012;33:153-76.
27. Meikle MB, Henry JA, Griest SE. The Tinnitus Functional Index: development of a new clinical measure for chronic, intrusive tinnitus. Ear Hear 2011.