

## TINNITUS MATCHING

Kamran Zamurrad Malik, Danyal Rashid, Zafarullah Khan, Chaudhry Altaf

Combined Military Hospital Hyderabad

### ABSTRACT

**Objective:** To study the pitch and loudness of tinnitus and to find minimal masking level.

**Study Design:** Descriptive analytical study.

**Place and Duration of Study:** This study was conducted at Combined Military Hospital Rawalpindi, the tertiary referral center for Pakistan Armed Forces from 1998 to 2001.

**Patients and Methods:** Patients with tinnitus were included in the study. Exclusion criterion was transient tinnitus settling on removal of offending agent like foreign body and not having tinnitus as major presenting feature. Patients were thoroughly interviewed and tinnitus card (questionnaire) was filled. Thorough general physical and Ear Nose Throat examination was carried out including relevant tests to elucidate any cochleovestibular pathology. All patients had pure tone audiometry and tinnitus testing and sophisticated investigations were carried out whenever indicated.

**Results:** Most patients of tinnitus were seen between age of 40 to 60 years and 76.6% patients were male. Hearing loss accompanied tinnitus in 90% patients and 53% patients had tinnitus of moderate intensity. Pitch match frequency of 4 kilohertz was seen in 25.3% while 29% patients had loudness match of tinnitus ranging from 55 to 70 decibel (dB). In vast majority (24%) minimal masking level ranged from 41 to 55 dB. Seventy nine percent patients had pitch match frequency at or around frequency of maximum hearing loss.

**Conclusion:** Tinnitus is seen predominantly among males and its frequency increases with age. It is usually of moderate intensity and is of high pitch which corresponds to frequency of maximum hearing loss. Pitch of tinnitus is not a good indicator of degree of annoyance while loudness match gives a good measure of annoyance. Minimal masking levels are at or around loudness match. Tinnitus in majority of patients is associated with mild to moderate degree of hearing loss.

**Keywords:** Tinnitus, Pitch, Loudness, Hearing Loss.

### INTRODUCTION

Tinnitus literary meaning ringing can be best defined as the conscious experience of a sound that originates in an involuntary manner in head of its owner or may appear to him to do so [1]. Tinnitus is common in all forms of otological disorders and is tenth most common presenting complaint among elderly in primary care. Fowler reported its presence in 86% of 2000 consecutive patients of aural disease [2].

It is important to test tinnitus in order to appreciate the pitch and loudness of tinnitus

which provide quantitative data serving as a base line to compare any changes occurring in the course of disease. Frequency and masking measurements were described first in 1931 by Josephson and also by Wegel [3].

Severity is the term used to describe intrinsic unpleasantness of tinnitus sound. Loudness is the property of tinnitus that might be expected to correlate best with severity but majority of tinnitus sounds are not very loud and have an annoying effect quite out of proportion to their loudness [4]. Generally a continuous tinnitus is more troublesome than fluctuant tinnitus. Patient's psychological reaction is the most important single component of severity. Meikle and

**Correspondence:** Maj Kamran Zamurrad Malik, Classifies ENT Specialist, CMH, Hyderabad  
Email: kamee1137@Yahoo.com

Received 25 Aug 2006; Accepted 30 April, 2008

Griest found that most patients have tinnitus of moderate intensity [5].

In general high pitched tinnitus causes more trouble than low pitched tinnitus.

Tinnitus measurement protocol should include assessment of frequency, loudness, masking characteristics and objective measurement [3].

Pure tones are used for pitch matching because they give purest representation of pitch and the presentation level of pitch matching stimuli have to be related to audiogram. Pitch match interpretation in terms of annoyance potential has weak predictive value. It is possible that some sounds are extremely unpleasant but defy measurement or definitive description due to their inherent subjectivity.

The patient's description of loudness and annoyance of tinnitus is the most relevant measurement. The tinnitus loudness match is best obtained with a pure tone from an audiometer, often at the pitch match frequency and in the ear with troublesome tinnitus sound. It is more useful for the patient to make judgments at the frequency that has the most sensitive hearing threshold level [6].

Loudness measurement is never fruitful because of increased sensitivity to noise at tinnitus frequency [7]. The masking decay occurring in 50% of cases militates against both meaningful measurement of minimal masking level and successful therapeutic use of complete masking [8]. In recent times a consensus has emerged that neither the loudness nor psychoacoustic measures of tinnitus bear a constant relationship to severity or perceived loudness of tinnitus. Nevertheless, quantification is needed in clinical trials of proposed treatments and in variety of other types of tinnitus research [9]. At present there is dearth of published material on this subject in Pakistan and this study is probably the first of its kind and it is believed that our study will augment tinnitus management.

## Objective of study

To study the pitch and loudness of tinnitus and to find minimal masking level.

## PATIENTS AND METHODS

This was a descriptive analytical study carried out in department of Ear Nose and Throat Combined Military Hospital Rawalpindi from January 1998 to January 2001.

All patients whose main presenting complaint was tinnitus were included in the study. Patients having transient tinnitus occurring in conditions like foreign body, cerumin - which settled after removal of offending agent were excluded from the study. Patients not presenting with tinnitus as a major complaint or those who admitted as having tinnitus on direct questioning were also excluded from the study.

All patients were thoroughly interviewed and tinnitus card (a simple questionnaire) was filled. Effects of tinnitus on hearing, life style, general health and emotional disturbances like despair or frustration were recorded. Patients were also asked to comment on the intensity of tinnitus on scale ranging from one to ten. The tinnitus was then graded as mild (0-3), moderate (4-7) and severe (8-10) according to scale. Tinnitus card also encompassed any associated deafness, maskability of tinnitus and hyperacusis.

All patients underwent thorough general physical and Ear Nose, Throat examination. After clinical examination patients underwent cochleovestibular investigation protocol. The protocol included blood complete picture, erythrocyte sedimentation rate and x-ray of internal auditory meati in lateralized cases. Blood sugar, lipid profile estimation, renal function tests and computed tomography were done if required. Hearing testing by tuning fork tests and pure tone audiometry to find cochlear or retro cochlear involvement, tympanometry, and tinnitus measurement including pitch match frequency, tinnitus loudness match and minimal masking level. Selected patients also required investigations like speech audiometry and brainstem

evoked response audiometry. The data thus obtained was arranged and analyzed on Special Package for Social Sciences Version 10.

**RESULTS**

A total of three hundred patients participated in the study. There were 70 (23.3%) females and 230(76.6%) males. The age ranged from 17 to 85 years. Eight (2.6%) patients were less than 20 years of age, 69 (23%) patients were between 20 and 40 years, 120 (42%) patients making the largest group ranged from 40 to 60 years of age, while 97 (32%) patients were older than 60 years.

Patients were divided into six categories according to hearing status and this is represented graphically in (fig. 1). Intensity of tinnitus in 113 (37.7%) patients was mild while 159 (53%) patients graded their tinnitus as moderate. It was graded as severe by 28 patients (9.3%). Pitch of tinnitus could not be matched in 3 (1%) patients. Depicts the pitch match frequency (fig. 2)

Loudness of tinnitus could not be matched in 3 (1%) patients. (fig. 3) represents loudness match. Tinnitus could not be masked in 30 (10%) patients. Minimum masking levels are shown in (fig. 4). Out of 267 patients with demonstrable hearing loss pitch of tinnitus matched with frequency of maximum hearing loss in 145 (54.3%) patients while 68 (25.4%) patients had pitch match frequency at an octave above or below frequency of maximum hearing loss. Pitch match frequency of tinnitus was completely different from frequency of maximum hearing loss in 54 (20.2%) patients (fig. 5).

Out of 15 (5.1%) patients having loudness of tinnitus up to 25 decibel (dB) , 9 had graded it as mild and 6 as moderate. of 84 (27.9%) who had tinnitus loudness match of 26 to 40 dB, 45 had mild tinnitus while 17 had moderate tinnitus. Tinnitus loudness range of 41 to 55 dB had 75 (25.3%) patients out of which 15 had mild, 45 had moderate and 15 had severe tinnitus. The largest group of 87 (29.3%) patients had tinnitus loudness match of 55 to 70 dB, out of these 41 had mild, 42

had moderate and 4 had severe tinnitus. Twenty seven (9%) had tinnitus loudness ranging from 71 to 90 dB , out of these 3 had mild tinnitus,18 had moderate tinnitus while 6 had severe degree of tinnitus intensity. All 9 (3%) patients with tinnitus loudness of more

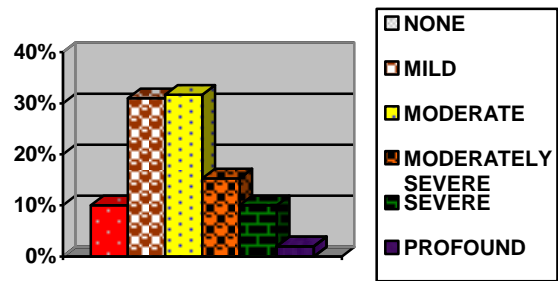


Fig.1: Hearing Loss

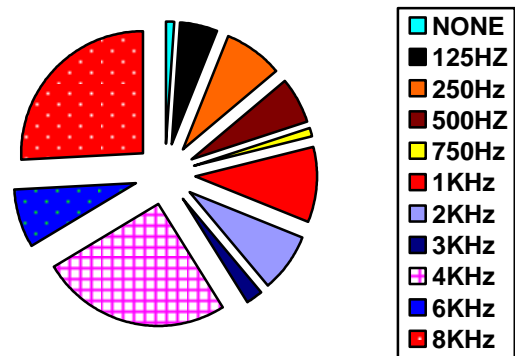


Fig.2: Pitch Match Frequency

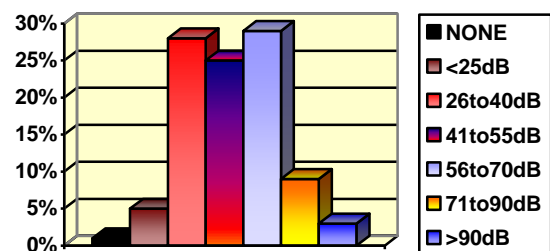


Fig. 3: Loudness Match of Tinnitus

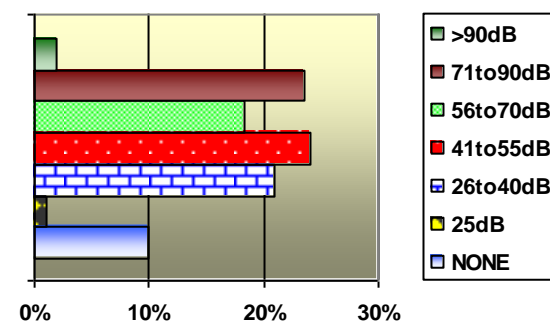
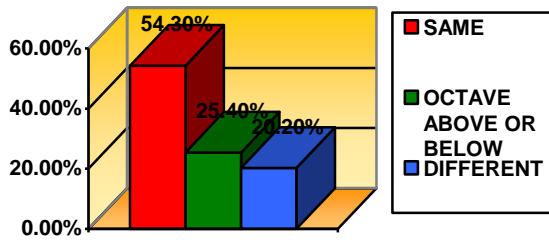


Fig.4: Minimal Masking Level



**Fig.5: Relation of Pitch of tinnitus and Frequency of Maximum Hearing loss**

than 90 dB graded their tinnitus as moderate.

## DISCUSSION

Tinnitus as a symptom deserves attention because it may be the first indicator of some important pathology e.g. acoustic neuroma. It is often accompanied by hearing impairment which may be causing considerable disability and still not recognized by the patient or it may be a warning sign of developing impairment and risk of future disability like noise trauma [1]. It is a symptom which can cause much suffering and anxiety concerning its causes and prognosis.

The vast majority of tinnitus patients belonged to age group of more than forty years. Tinnitus was least common in patients of less than 20 years of age. These findings are in conjunction with preexisting epidemiological studies [10-12]. Males outnumbered females and this is in contradiction to studies carried out in other parts of world which have shown almost equal incidence in males and females [10-12]. This contrast is attributable to the fact that major chunk of our patients comprised of patients of armed forces which are predominantly male.

Ninety percent of patients with tinnitus had accompanying hearing loss and this is in accordance with other studies. For example Coles et al [1] had reported an increase in prevalence with high tone loss, Chung et al [11] found that tinnitus was more common in ear with greater hearing loss. Similarly Alberti [13] and Axelson [14] found tinnitus is related to threshold shift in noise induced hearing loss.

In our study tinnitus is mostly associated with mild to moderate degree of hearing loss. This is in contradiction to Ylikoski [15] who had found that tinnitus was most common among men with severe or disabling hearing loss.

Majority of patients (53%) graded their tinnitus as moderate. This is in accordance with Meikle et al [5] who found incidence of moderate intensity to be 45%. The presentation of patients with moderate intensity reflects the degree of annoyance caused by it compelling patients to seek medical advice. Majority of patients had high pitch match frequency of tinnitus. Seventy six patients matched at 4 kilohertz (kHz) and 77 matched at 8 kHz. Out of those who matched at 4 kHz only 3.3% had severe tinnitus while 10% and 12% had moderate and mild intensity of tinnitus respectively. Those who matched at 8 kHz, had only 2% patients with severe tinnitus, majority suffered from moderate (13%) and mild (10.6%) intensity of tinnitus.

Though high pitched sounds are more annoying but from the study it is apparent that it is not a good correlate. This is in accordance with Coles [1] who mentioned that pitch match interpretation in terms of annoyance potential is uncertain. It is possible that some sounds are extremely unpleasant but defy measurement or definitive description due to their inherent subjectivity.

Majority of patients had pitch match frequency similar to that of hearing loss. This supports the cochlear model of tinnitus and is in agreement with Coles [1] who mentioned that pitch match frequency occurs in the region of, at lower edge of or just before any noise induced hearing loss. Ueda [16] had found that a high pitched tinnitus nearly corresponds with hearing type that is pitch of tinnitus is also in accordance with disturbed frequency in hearing threshold.

Most patients had loudness match in region of 56 - 70 dB followed by those who had loudness match from 26 - 40 dB. Only few patients had loudness match of above 91 dB and out of these none had severe tinnitus.

Majority of patients had graded their tinnitus as moderate and out of this major group had loudness match of less than 70 dB. It is apparent that loudness match is generally a good measurement of annoyance of tinnitus. This was also stated by other authors [1]. Patients with very high loudness matches not experiencing severe tinnitus may be due to subjective phenomenon including strong personality. This is in contrast to Jastreboff who stressed that loudness measurement is never fruitful because of increased sensitivity to noise at tinnitus frequency [7].

Out of 270 patients whose tinnitus could be masked 75 patients had masking level at loudness match, 162 patients had masking of tinnitus at level within 10 dB while 33 patients had masking of tinnitus at greater level.

Though thought to be useful in masker development the importance of minimal masking level has largely disappeared with increased use of partial masking of tinnitus. Minimum masking level indicates how well central auditory pathways can recognize tinnitus related neuronal activity in presence of noise [7].

## CONCLUSIONS

In our setup tinnitus is seen predominantly in males and its incidence increases with increasing age. It is usually of moderate intensity and is of high pitch which corresponds to frequency of maximum hearing loss. Pitch of tinnitus is not a good indicator of degree of annoyance while loudness match gives a good measure of annoyance. Minimal masking levels are at or around loudness match. Tinnitus in majority of patients is associated with mild to moderate degree of hearing loss.

## REFERENCES

1. Coles RRA. Tinnitus. In: Stephens D).Scott-Brown Otolaryngology 6th ed. Butterworth-Heinemann Oxford; 1997: 1-34.
2. Fowler EP. Head noises in normal and in disordered ears: significance, measurement, differentiation and treatment. Archives of Otolaryngology .1944; 39:498-503.
3. Hazell JW. Ciba Foundation Symposium .1981; 85:35-53.
4. Sood SK, Coles RRA. Hyperacuses and phonophobia in tinnitus patients. Br. Journal of Audiology. 1988; 22:228.
5. Meikle MB, Griest SE. Computer data analysis registry. In: Abraham Shulman, Jean Marie Aran, Jack A Vernon. Tinnitus diagnosis / treatment. Lea and Febiger. Philadelphia 1991; 416-30.
6. Goodwin PE, Johnson RM. The loudness of tinnitus. Acta Oto-Laryngologica 1980; 90: 353-9.
7. Jastreboff PJ, Hazell JWP, Graham RL. Neurophysiological model of tinnitus: Dependence of minimal masking level on treatment outcome. Hear Res 1994; 80: 2: 216-32
8. Penner MJ, Brauth S, Hood L. The temporal course of the masking of tinnitus as basis of inferring its origin. J of Speech and Hearing Disorders 1981; 24: 257-61.
9. Henry JA, Fausti AS, Flick CL, Helt WJ, Ellingson RM. Computer -automated clinical technique for tinnitus quantification. Am J Audiol 2000; 9: 1: 36-49.
10. Coles RRA. Epidemiology of tinnitus, prevalence, demographic and clinical features. Journal of Laryngology and Otology 1984 suppl. 9:7-15 and 195-202.
11. Chung DY, Gannon RP, Mason k. Factor effecting prevalence of tinnitus. Audiology 1984; 23:441-52.
12. Shulman A. Introduction, Definition and Classification of Tinnitus: In Tinnitus Pathophysiology and Management Tokyo: Igakushoin, 1988: 1-6.
13. Alberti P W. Tinnitus in occupational hearing loss .Journal of Otolaryngology 1987; 16: 34-5.
14. Axelson A Barrenas ML. Tinnitus in noise induced hearing loss. In: Dancer ALL, Henderson D (edi). Noise induced hearing loss. Mosby Year Book St. Louis 1992: 169-76.
15. Ylikoski ME, Ylikoski JS. Hearing loss and handicap of professional soldiers exposed to gunfire. Scand J work Environ Health 1994; 20(2):93-100.
16. Ueda S, Asoh S, Watanabe Y. Factors influencing the pitch and loudness of tinnitus:

Tinnitus Matching

Pak Armed Forces Med J 2009; 59(1): 85-89

Nippon Jibiinkoka Gakkai Kaiho. 1992; 95; 11:

1735-43.

.....