

Effectiveness of sound enrichment and counseling in the treatment of tinnitus

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Abstract

Various management methods have been proposed for individuals with clinically significant tinnitus. Among these several methods for tinnitus management a few have gained wide acceptance and generally regarded as a viable management option. Two of these methods, Tinnitus Retraining Therapy (TRT) and Tinnitus Masking (TM) are similar in that they both employ sound therapy although they have different rationales and use different protocols for the purpose. But each of these methods has certain limitations making it difficult to apply in the Indian scenario. In order to overcome these limitations more practical and cost-effective method that will combine certain features of both the methods have been proposed and factors affecting its efficacy have been discussed. Two proposed methods are, one in which the participants were administered management through periodic visit labeled as Group I and second is through correspondence labeled Group II. Reduction in severity was more for those in Group I than for Group II. Second observation made was that maximum improvement was seen in participants with severe tinnitus than those with less severe tinnitus. Third, there was no statistically significant difference between the groups and within the groups with different duration of tinnitus. Fourth, there was a moderate correlation between moderate sensorineural hearing loss and amount of improvement with proposed methods. Finally, it was observed that there was a strong correlation between the baseline scores and rate of improvement in first, second and third month for both the groups.

Introduction

For individuals with clinically significant tinnitus a handful of management methods have gained wide acceptance. Two of these methods, Tinnitus Retraining therapy (TRT) and Tinnitus Masking (TM) are similar in that they both employ sound therapy although they have different rationales and use different protocols for the purpose (Henry, Schechter, Negler & Fausti, 2002).

The central premise of tinnitus masking involves the use of a wearable ear level device that delivers sound to the patient's ear in order to produce a sense of relief from the annoyance caused by the tinnitus (Vernon & Miekle, 2000). The relief is accomplished by covering up the tinnitus sound or by changing the sound of tinnitus in some way usually by reducing its loudness. A number of studies have reported clinical outcome data for treatment of a large number of individuals with tinnitus using the basic method of tinnitus masking. The resulting data reviewed by Vernon, and Meikle (2000) indicate success rate of TM ranging from 45 to 77%. Limitation of tinnitus masking is that it is not equally efficient in alleviating the problem of all clients; in

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fact, many of the patients cannot be helped solely with this technique. Further, it is imperative to purchase tinnitus masking device and hence it may not be a cost-effective management.

Tinnitus retraining program (Jastreboff, 1990, cited in J.P.Jastreboff & W.L.Hazell, 2004) of tinnitus management is based on the neurophysiological model. The essence of this model is that there are two other systems involved, the limbic system and the autonomic nervous system. The limbic system controls our positive as well as negative emotions such as fear, thirst, hunger, joy and happiness. The limbic system is strongly connected with all the sensory systems (Bast, Zhang & Feldon, 2001). The autonomic nervous system is closely related to the emotional system (Brooks, 1987).

Tinnitus retraining therapy (TRT) has two important aspects; one is sound enrichment which aims at habituating the tinnitus by providing continuous low level non-annoying sound rather than masking tinnitus (making tinnitus inaudible). The second aspect includes counseling which will be adjusted to individual patient bearing in mind the needs of the individual and their general psychological status. The limitation of TRT includes its strict adherence to the recommended regimen for 12 to 24 months which may be difficult to follow and patients are advised to return to the clinic for a minimum of 3 or 6 weeks and at 3rd, 6th, 12th and 18th month interval.

The aims of the present study included:

- i) To assess and compare the effectiveness of two viable modes of tinnitus management, periodic follow-up and correspondence.
- ii) To assess the effect of duration of tinnitus and final outcome with the proposed two methods of management.
- iii) To assess the correlation between hearing loss and progress in those with these proposed techniques.
- iv) To assess the correlation between the severity of tinnitus (baseline score) and amount of improvement with the proposed management method.

Method

Participants

Two groups of participants were considered. In both groups the participants were considered for the study only upon passing the following criteria: age range between 15 and 55 years, fluency in Kannada language, literate (basic qualification being PUC passed), with persistent tinnitus in both ears, with and without hearing loss and without complaint of hyperacusis. Hearing loss if present was less than moderately-severe degree of sensorineural type.

The basic difference between the two groups of participants was:

Group I consisted of participants with persistent tinnitus who could attend the therapy sessions for a period of three months. **Group II** consisted of participants with persistent tinnitus

but who could not stay for the duration of tinnitus management. These participants were enrolled for management through correspondence.

Test equipment

- A calibrated dual channel diagnostic audiometer (MA-53), with TDH-39 headphones and Radio ear B-72 bone vibrator was used for selection of participants.
- A calibrated immittance meter (GSI-Tympstar) was used for the selection of the participants for the study.

Test Environment

All the testing was conducted in an air-conditioned, acoustically treated single or double room set-up depending on the test. The ambient noise levels inside the test room were within permissible limits.

Procedure

The procedure consisted of the following steps:

1. Selection of participants
2. Audiological evaluation of tinnitus
 - a. Psychoacoustic measures of tinnitus
 - b. Subjective evaluation on using Self-report tinnitus handicap questionnaire (SR-THQ) by Shanbal, (2001)
3. Management of tinnitus.

1. Selection of participants:

For selection of participants a detailed case history was collected along with pure tone audiometry, speech audiometry and immittance evaluation being carried out. Participants meeting above criteria were selected for the study.

2. Audiological evaluation of tinnitus:

This included psychoacoustic evaluation and subjective evaluation of tinnitus.

a. Psychoacoustic Evaluation of the Tinnitus

This included pitch matching, loudness matching and masking (residual inhibition & Feldman's masking curve). These tests were administered before starting the management, during and after the management process to monitor the reduction with management method.

i) Pitch matching

This measure attempted to quantify the tinnitus for frequency. Two alternative forced choice (2AFC) method was used (Vernon & Ferwick, 1984, cited in Schechter & Henry, 2002). Two tones with different frequencies were presented alternatively to the participant and the participant was instructed to indicate which tone was more like his/her tinnitus. The frequency of tones was varied until the participant could match the frequency with that of their tinnitus.

ii) Loudness matching

Loudness match was done by using Penner's (1983) method of adjustment technique, an ascending procedure. The signal that was matched for the pitch of the tinnitus was presented to the participant and the intensity of a comparison tone was adjusted by the tester until it was barely audible (threshold) and later the tester varied the intensity of the tone till the participant matched the loudness with that of his/her tinnitus. The difference in levels between the thresholds and level at which tinnitus was matched for loudness was considered as the loudness of the tinnitus.

iii) *Minimum masking level*

Masking curves were obtained by presenting narrow band noise (NBN) at each of the discrete frequencies i.e., 250 Hz, 500 Hz, 1 KHz, 2 KHz, 3 KHz, 4 KHz, 6 KHz, 8 KHz and at the frequency of the tinnitus match. Masking noise was presented to the affected ear under headphones starting at intensity equal to the loudness of tinnitus and was slowly increased while the participant was instructed to indicate when the noise first became inaudible. Sound intensity was increased in small steps until the participant reported that the tinnitus was no longer audible in that ear. The minimum level at which the participant reported hearing only the external sound and not his or her tinnitus was the level recorded as the minimum masking level (MML) on the masking curve. Out of 20 participants eight got persistence type, eight got congruence type and remaining got convergence type.

iv) *Residual Inhibition*

A white noise at minimum masking level plus 10 dB for 60 seconds was presented to the participant under headphones. At the end of 60 seconds the masking noise was removed and the subject was asked to indicate as to whether there was any change in the perception of tinnitus. This residual inhibition was classified into four types (Goldstein & Shulman, 1991). Residual inhibition type obtained in eight out of the twenty participants was positive partial type, that is, the participants reported tinnitus loudness to be less than what was before the measurement of residual inhibition. Negative type residual inhibition was obtained in seven of twenty participants. That is, no change in tinnitus perception following one minute of exposure to noise. Three of the remaining participants reported rebound type of residual inhibition that is increase in tinnitus.

b. Subjective evaluation of tinnitus - Administration of SR-THQ

In addition to the case history and psychoacoustic measures, Self- Report Tinnitus Handicap Questionnaire (SR-THQ) by Shanbal (2001) was administered.

3. Management of tinnitus

This stage consisted of counseling and sound therapy. Each counseling session was tailored-made taking into account all the information gathered from each participant. The counseling session contained the following information –

- a. Explanation of the result of audiological testing. The function of the peripheral auditory system was explained to the participant with diagrams and copies of the participant's test results.
- b. Presentation of basic rules of perception including the impact of contrast on signal strength. Participants were explained about how neuronal network in the brain are trained to detect important sounds automatically. For that classical example was given such as the ability to hear the sound of our own first name even in high level of competing background noise and when we are not expecting it. The identical scenario process in tinnitus was also explained such as the initial signal once recognized and evaluated as important because of its continuous presence, cause tuning of neuronal networks to its pattern and the auditory system can easily recognize it, even in the absence of other signal. Likewise, loudness perception depends upon the contrast of signal against background.
- c. Presentation of the basics of brain function and the interaction of various different systems of the brain. All the participants were told about how the brain has the ability to undergo modification and plastic changes. So, the participant was made clear that the retraining of conditioned reflexes is possible but takes time. The role of the other systems in the brain that activated by tinnitus, in addition to the auditory system was also explained. The limbic system in the brain controls emotions and is strongly related to the auditory system.
- d. Relating these basic concepts to specific participants explaining why tinnitus creates such profound effect.
- e. Explanation of theoretical basis of habituation and how it can be achieved.
- f. Discussion with the participant about the proposed treatment including discussion regarding the role and utilization of sound with pictures attached in Appendix 'B'.
- g. Answering any additional questions that the participant may have on the basis of neurophysiological model.

Participants were also explained the rationale and importance of Sound therapy i.e., maintaining enriched environment of non-annoying sound to maximize treatment effects. In addition to counseling, the participants in Group I and Group II were given sound therapy. The sound therapy protocol was intended to modify auditory processing at sub-conscious level so that neural changes facilitated by sound therapy would promote habituation to tinnitus perception.

Counseling was provided periodically once in 25 days in order to remove negative thoughts about tinnitus along with sound enrichment, only for Group I. Counseling for three months by asking participants to visit in order to monitor the use of sound therapy was done only for Group I, participants in Group II were provided with counseling only once, i.e., at the end of the tinnitus evaluation.

The SR-THQ was administered before, during (at one month interval) and after 3 months of the management program. This was done to monitor the progress in management of tinnitus. The data for each participant in each group were tabulated for statistical analysis.

Results and Discussion

To investigate the goals of the present study statistical analysis was carried out using SPSS for windows (version 10.0) software.

I. Comparison of the effectiveness of periodic FU and correspondence in tinnitus management:

As a first step to investigate which management program was more beneficial for participants with tinnitus, the mean score on SR-THQ of Group I was compared with that of Group II over three months period. It was observed that the reduction in severity of tinnitus on SR-THQ was more for those in Group I who were asked to visit the clinic on periodic basis than for those in Group II who were seeking help through correspondence. Possible attributing factors for this difference could be clinical contact time and monitoring of sound enrichment. Though both the groups were given counseling and sound enrichment it was not possible to monitor the duration and the loudness of the sound used by the participants in Group II for sound enrichment. Second possible variable contributing for this difference could be clinical contact time. Group I was given more intensive counseling in terms of systematically educating them about tinnitus and by giving different analogies and examples in order to demystify or take out negative association of tinnitus leading to more improvement.

A second observation in this study was with respect to improvement seen only on quantitative measures and not on qualitative or psychoacoustics measures. However there was a significant difference on qualitative analysis, i.e., on SR-THQ suggesting importance of administration of such measures. It also indicates that even when there is a reduction in subjective disturbance from tinnitus three months of management program it does not correlate with reduction in other quantitative measures.

The third aim was to check for interaction effect between the duration of tinnitus and amount of improvement with proposed methods. One way ANOVA was administered for Group I to analyze the interaction effect of duration of tinnitus on baseline scores i.e., severity of tinnitus as well as on rate of improvement. There was no statistically significant difference between the groups and within the groups with different duration of tinnitus ($F = 0.648$, $p > 0.05$) for the mean baseline score. In other words severity of tinnitus did not depend upon the duration of tinnitus. Similarly F values were obtained for first month score, second month score and third month scores in individuals with different duration of tinnitus. Values obtained are ($F = 0.766$, 0.744 , 0.594 , for scores obtained in first, second and third month of management respectively; $p > 0.05$). In other words the rate of improvement with a participant and between participants is not varying according to duration of tinnitus. Similar findings were obtained for Group II also.

In third step Pearson's product moment correlation was applied to Group I to find out the relationship between hearing loss and rate of improvement. In first, second and third months of treatment values obtained were $r = 0.502$, 0.529 , and 0.525 respectively, indicating moderate positive correlation. In other words as hearing loss was increasing in participants with tinnitus the amount of change over a period was more.

This may be related to various causes of the tinnitus. It has been found that abnormal activity of hair cells or abnormal functioning of most peripheral part of the auditory nerve generates some forms of tinnitus in the ear. Exposure to loud sounds (noise) or administration of ototoxic drugs can also cause tinnitus that is associated with hearing loss. Noise and ototoxic

drugs are assumed primarily to affect the ear (hair cells) but the severe form of tinnitus may in fact be generated in the CNS as a result of deprivation of input or perhaps because of abnormal input from the ear. Such involvement of central nervous system becomes more and stronger as the degree of hearing loss increases. As the central involvement increases tinnitus becomes more debilitating and annoying. As the severity of tinnitus increases the rate of improvement also increases in such individuals than with individuals with less severity of tinnitus.

In the final step Pearson's product-moment correlation was applied to check the correlation between the baseline scores and rate of improvement in first, second and third month for Group I. Correlation values obtained were $r = 0.997$, 0.994 , 0.999 respectively, indicating that as baseline scores increases rate of change in scores or rate of improvement also increases. Similar finding were obtained for Group II with $r = 0.997$, $r = 0.994$ and 0.999 for rate of improvement in first, second and third month.

Summary and Conclusion

Two of the methods for tinnitus management, Tinnitus Retraining therapy (TRT) and Tinnitus Masking (TM) are similar in that they both employ sound therapy although they have different rationale and use different protocols for the purpose.

TRT is a program of tinnitus rehabilitation that is based on the neurophysiologic model of tinnitus (Jastreboff & Jastreboff, 2003). One of limitation of this method is its strict adherence to the recommended regimen for 12 to 24 months which may be difficult to follow and patients are advised to return to the clinic for a minimum of 3 or 6 weeks and at 3, 6, 12 and 18 month interval.

In order to overcome the above limitation a more practical and cost-effective method was evaluated that combined certain features of both the treatments. It was observed that the proposed methods of treatment were beneficial for participants with tinnitus. But periodic visits are more beneficial for participants with high baseline score than for participants with less baseline score on SR-THQ. The most potential factor that was found to be affecting the rate of improvement was severity of tinnitus. That is more the severity of tinnitus greater was the improvement. There was no difference in scores before and after the treatment on qualitative psychoacoustic measures. It was also observed that the hearing loss was also moderately correlated with the rate of improvement. There was no interaction effect between the duration of tinnitus and rate of improvement.

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