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ORIGINAL ARTICLE

Efficacy of TRT Using Noise Presentation from Mobile Phone

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Abstract The purpose of tinnitus retraining therapy (TRT) is to induce habituation, first of the reaction to the tinnitus signal, and subsequently to habituate the perception of tinnitus itself. Habituation of sound is achieved through sound treatment which involves the use of low-level broadband noise mainly through noise maskers. Noise maskers are costly hence there is a need to find an alternate source of noise like MP3 and mobile phones. The goal of present study was to find out whether persons with tinnitus may be successfully treated with TRT using sound treatment from the noise presented through mobile phones. Total 30 male adult patients with tinnitus were enrolled for TRT. TRT comprised of two activities i.e. directive counseling and sound treatment. The most efficient noise stimulus was tape recorded by presenting the noise in the sound field using speakers and was recorded using a digital tape recorder. The recorded noise was saved to the mobile phone of the person with tinnitus and was asked to play it using hands-free at the level which was just audible for the duration of 3–4 hours per day. The Tinnitus interview forms were used to measure: (1) Percentage awareness of tinnitus, (2) Percentage of the time it caused distress and (3) Number of life factors affected. After 6 months these measurements were repeated and an improvement score of 40% was taken as criteria for the significant success of TRT. Out of 30 patients, 25 could continue coming for follow up sessions. Out of these 25 patients, 17 patients (68%) showed significant improvement. The sound treatment may be provided with the help mobile phones, which is a cheaper substitute for costly noise maskers.

Keywords Tinnitus · Tinnitus retraining therapy · MP3 · Sound treatment · Tinnitus interview forms

Introduction

Tinnitus has been defined as the situation where there is a sensation of sound experienced by the tinnitus sufferers but there is no corresponding sound in acoustic environment [1]. In a study, the prevalence of tinnitus in adults ranges from 10.1 to 14.5% [2]. However, the prevalence of clinical tinnitus in patients who seek medical advice is around 7.2% and mainly in the urban population [3]. Tinnitus is associated with a range of physical and emotional disorders [4]. There are four psychosocial consequences of devastating tinnitus namely employment status, somatic diseases, psychic disturbances and psychosomatic disturbances. These consequences create a vicious feedback loop by reinforcing the distress caused by tinnitus to these persons [5]. Management of tinnitus includes medical, surgical, hearing aids, tinnitus masking, tinnitus retraining therapy, cognitive behavior therapy, electrical stimulation and Complementary and Alternative Treatment methods. However, not a single tinnitus treatment approach can claim unequivocal research evidence demonstrating consistent success for all cases [6].

TRT was developed by Jastreboff and is a clinical implementation of his "neurophysiological model of tinnitus" [7]. The TRT neurophysiological model describes tinnitus as being caused by an aberrant signal in the auditory nervous system that has been conditioned to activate the limbic and autonomic nervous systems, resulting in

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emotional reactions and stress [7]. The aberrant signal must undergo reconditioning to be reclassified by brain processing centers as a meaningless, unimportant signal. The reconditioning process is referred to as "retraining" the brain to habituate to the tinnitus signal. The primary objective of TRT is habituation of the negative reactions associated with the tinnitus [7]. This objective is achieved through structured educational counseling. The second objective is habituation of tinnitus from conscious perception. The second objective involves "sound therapy," which is the use of constant low-level sound to reduce the "detectability" of tinnitus at subconscious levels. The state of reduced detectability of the tinnitus signal must be maintained for a sufficient period of time to retrain the tinnitus signal processing mechanism. Sound therapy involves the use of hearing aids or broadband noise through wearable sound generators, or use of environmental sounds through CDs and tabletop sound machine. Wearable sound generators and combination instruments are expensive device [8]. More recently, music with an embedded broadband noise was used in the development of an acoustic desensitization protocol [9]. According to Jastreboff's original description of TRT, the broadband noise was used for sound therapy to decrease the strength of the tinnitus signal by increasing the level of background neuronal activity in the auditory system. TRT is a well-established treatment modality of tinnitus and a published article demonstrated an 80% improvement in tinnitus patients treated with TRT. A study by Sheldrake et al. [11] suggested that out of 224 patients receiving full TRT, 83.7% achieved a significant benefit using the 40% improvement criteria.

There have been studies on the efficacy of modified versions of TRT. Fukuda et al. [12] compared the traditional way of TRT using a hearing aid and tinnitus masker with the alternate environmental sound source through Portable Music Players (PMPs) and found efficacy of TRT in terms of reduction in THI scores as 71, 67, and 71% respectively. Similarly in a study conducted by Bong Jik Kim et al. tinnitus patients were given sound therapy presented through MP3 player using three types of sounds i.e. broadband noise, narrow band noise, and mixed noise. It was found that all three sounds could provide relief in patients with annoying tinnitus after TRT (77.8, 37.5, and 58.3% respectively) [13].

Need for the Study

With such a large number of persons suffering from tinnitus, using costlier noise maskers from the market for sound treatment under TRT is not a viable option for most of the patients in India. The mobile phone is a widely used gadget which is useful to play media files just like an MP3 player. However, there is no study available to measure the efficiency of TRT using mobile phones as a source of noise. Hence there is need to study the efficacy of using mobile phones to present desired noise for sound therapy under TRT program.

Goal

Goal of the present study was to find out whether persons with tinnitus may be successfully treated with TRT approach using sound treatment from the noise presented through mobile phones.

Methodology

Total 30 male adult patients with tinnitus were enrolled for tinnitus retraining therapy at ENT Department, PGIMER, Chandigarh. A detailed case history of the patients was taken and the measurements used were: (1) Percentage awareness of tinnitus over the previous week during waking hours; (2) Percentage of the time it caused distress or annoyance; and (3) Number of life factors affected (sleep, concentration, relaxation, work). Data were recorded during a direct structured interview with the patient using TRT interview forms [14].

Patients were then categorized under following five categories [10, 15, 16]:

Category 1 Persons with tinnitus, and no significant hearing difficulties. Treatments provided were directive counseling and sound treatment. There were total 12 subjects in this group. 10 subjects could come for 6 months to complete the TRT program.

Category 2 Persons with tinnitus, and significant subjective hearing difficulties; Treatments provided were counseling and sound treatment along with hearing aids to amplify environmental sound. There were total 10 subjects in this group and 8 subjects complete TRT program.

Category 3 Persons with hyperacusis with or without tinnitus, hearing loss irrelevant, and having no kindling effect as in Category 4; Treatment provided were counseling and desensitization using noise stimuli (sound treatment). There were 3 subjects in this group and all 3 completed TRT program.

Category 4 Persons with hyperacusis (intolerance towards loud sounds) with or without tinnitus and with a prolonged effect on symptoms after noise exposure. Treatment provided was intensive counseling and sound treatment. There were 5 subjects in this group and 4 completed the TRT program.

Category 0 Persons with tinnitus presenting as a minor problem. This group was not included in the treatment.

For characterizing the individual's tinnitus following tests were performed:

1. *Pitch matching* Patient was asked to match the pitch of tinnitus with the pitch of particular tone presented by an audiometer. We used pure tone, narrow band noise, speech noise stimuli separately.
2. *Loudness matching* After pitch matching patient was asked to match the loudness of his tinnitus with the intensity of each stimulus separately.
3. *Residual inhibition* It is a temporary quieting or decrease in perceived intensity of tinnitus that can happen after listening to the right type of sound. Residual effect was obtained by presenting a particular stimulus (broadband/narrowband noise) at 10 dB above the level that just masked their tinnitus intensity for a duration of 1 min continuously and patient was asked to indicate till what time he was not perceiving the tinnitus and or till what time loudness of tinnitus of lesser than he used to perceive before presentation of stimulus. The stimulus producing more residual inhibition effect was the considered the most efficient.

TRT comprised of two activities i.e. directive counseling and sound treatment.

Directive counseling It was aimed at educating the patient with the understanding of what caused their tinnitus. The physiology of the auditory system was explained to the patient with a detailed explanation of the mechanism of tinnitus. Patients' specific anxieties about of tinnitus were identified and tinnitus was explained to be a benign and harmless phenomenon, which could be reduced and sometimes eradicated by appropriate treatment. The frequency of such counseling sessions was once in 2 months.

Sound treatment The efficiency of the two noise types i.e. narrowband/broadband noises was assessed using pitch matching, loudness matching and residual inhibition tests as explained above. Noise type which showed more degree of residual inhibition and which was more effective to match the tinnitus was chosen for sound therapy. The most efficient stimulus was recorded by presenting the stimulus in the sound field using speakers and was recorded using a digital tape recorder. The total duration of the recording was 15 minutes. The recorded stimulus was converted into MP3 format and the same was saved on the memory card of the patients' mobile. Patients were counseled to play the sound file using the hands-free at the level which was just audible (mixing point) for the duration of 3–4 hours per day.

The measurements used were: (1) Percentage awareness of tinnitus, (2) Percentage of the time it caused distress and (3) Number of life factors affected. Measurements were repeated after a period of 6 months. A significant improvement score of 40% [11] was taken as criteria for the success of TRT program. Patients were assessed as being successfully treated if they had either 40% improvement in annoyance and awareness; or 40% improvement in annoyance or awareness, plus an improvement/facilitation of one life factor. One sample paired *t* test was administered to find out the significance of the mean difference between pre-TRT and post TRT measures of the above mentioned three factors namely percentage awareness of tinnitus, Percentage of the time it caused distress and Number of life factors affected.

Results and Discussion

Out of 30 patients, 25 could continue coming for follow up sessions. Out of these 25 patients, 17 patients (68%) showed significant improvement with reference to criteria of 40%. Percentage of significant improvement seen in each category is as follows:

1. In category 1—8 out of 10 patients (80%)
2. In category 2—6 out of 8 patients (75%)
3. In category 3—2 out of 4 patients (50%)
4. In category 4—1 out of 3 patients (33%)

Figure 1 shows the percentage of persons with tinnitus achieving significant improvement. Out of 25 patients who had completed TRT program, 17 (68%) have shown significant improvement while 8 (32%) patients did not show significant improvement.

Figure 2 shows the change in mean awareness of tinnitus and mean distress caused by tinnitus in percentage, and Fig. 3 shows mean number of life factors affected by tinnitus of patients who showed significant improvement after completion of TRT program respectively. As shown in Fig. 2 the mean awareness of tinnitus in the pre-TRT assessment was 75% which reduced to 41.11% post-TRT. It also shows that mean distress caused by tinnitus pre-TRT assessment as 46.11% that reduced to 23.61% post-TRT assessment. Similarly as shown in Fig. 3 mean number of life factors affected by tinnitus was 3.5 in pre-TRT

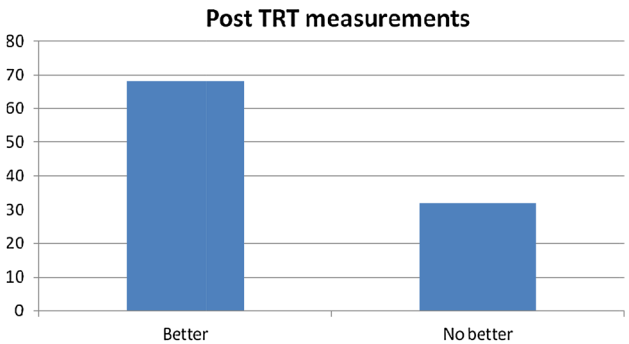

Fig. 1 Percentage of persons with tinnitus achieving significant improvement

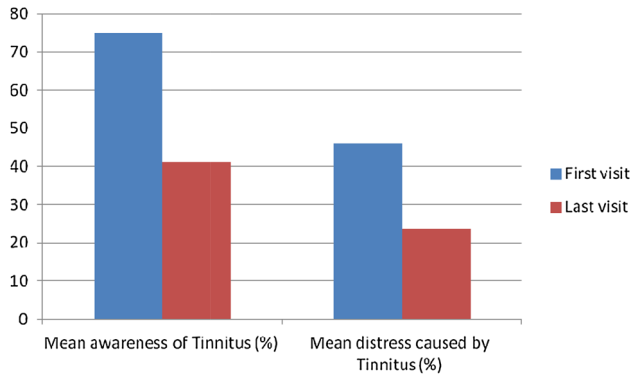

Fig. 2 Change in mean awareness of tinnitus and change in mean distress caused by tinnitus in persons with tinnitus who showed significant improvement after TRT

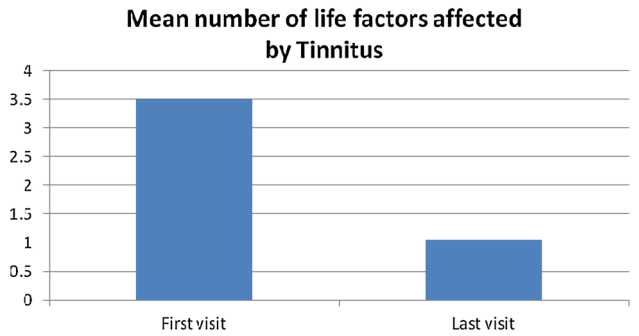

Fig. 3 Change in mean number of life factors affected by tinnitus in persons with tinnitus who showed significant improvement after TRT

assessment which decreased to 1.06 in post-TRT assessment.

Discussion

This study shows that after treatment with TRT using the sound treatment by the presentation of masking stimuli through mobile phones 68% of our patients who completed 6 months of the treatment protocol had a significant successful outcome. The criterion for significant success was strict and was chosen to avoid placebo effect. The process of habituation caused by TRT depends on neural plasticity, and plastic changes occurring in the central auditory system [11]. It reflects the establishment of a new interneural network for auditory perception and elimination of aberrant auditory phenomena (i.e. tinnitus). This process is a gradual one. The study highlights the role of mobile phones as a source of noise in TRT which is very cost effective and has shown significant benefits. Further study needs to be conducted on the long term effects of this version of TRT as well as the difference in outcome due to the type of stimuli i.e. broadband noise and narrowband noise.

Conclusion

TRT is an effective tool in the management of tinnitus and if given for a longer duration may decrease the perception of tinnitus as well as may improve the quality of life for the persons with tinnitus. The sound treatment which is a very important element of TRT may be provided with the help mobile phones which are a cheaper substitute for costly noise maskers. More studies are warranted in this direction.

Compliance with Ethical Standards

Conflict of interest There was no conflict of interest.

Ethical Approval All procedures performed in studies involving human participant were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed Consent Informed consent was obtained from the participants included in the study.

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