Management of Tinnitus: A Comparative Study

[1]Tanvi G. N. & [2]Geetha C.

Abstract

The present study aimed to evaluate the efficacy of two intervention procedures for tinnitus sufferers, Notched music therapy and White noise therapy. Two groups with five participants each, with chronic continuous tonal tinnitus were included in the study. Each of the two therapy groups had five participants who received therapy for 20 sessions of one hour each. For evaluating the efficacy of two therapy techniques, the measures considered were: Tinnitus loudness measured through loudness matching procedure and Tinnitus Severity Index Questionnaire (TSIQ) scores. The results revealed that both the therapy techniques provided significant benefit in treating tinnitus. However, notched music therapy was found to provide more benefit than white noise therapy, though this difference was not statistically significant.

Key words: *Tinnitus, notched-music therapy, white noise therapy.*

Introduction

'Tinnitus' is derived from a Latin word 'tinnire' which means to tinkle or ring like a bell. McFadden (1982) defines tinnitus as "the conscious experience of sound that originates in the head". According to Jastreboff (1995) "tinnitus is the perception of sound that results from activity within the nervous system without any corresponding mechanical, vibratory activity within the cochlea, and not related to external stimulation of any kind". The condition is symptomatic of some abnormal state of the auditory system and is not a disease entity in itself (Newman & Sandridge, 2006).

Various tinnitus treatment techniques are available which includes medical and surgical management, psychological managements, acoustic therapy and habituation therapy. Acoustic or sound therapy uses external sounds to provide relief to patients suffering from tinnitus and is said to be useful to any other treatment options (Jastreboff & Hazell, 2004). It is based on tinnitus masking procedures using different prosthetic aids for the management of tinnitus and it includes hearing aids, sound generators or tinnitus maskers. Regardless of the form of treatment, generally, broadband noise is used in one way or another to distract attention from the tinnitus and to reduce the brain's perceived need for stimulation (Jastreboff & Hazell, 2004).

Habituation therapy for tinnitus management aims at filtering and blocking the tinnitus related neuronal activity from reaching the area in the brain that is responsible for consciously perceiving tinnitus. The habituation of tinnitus can be achieved through various methods. One of which is Tinnitus Retraining Therapy (TRT).

TRT is a clinical implementation of the neurophysiological model (Jastreboff, 1990) of tinnitus. Recognition of the importance of the contributory effects of the limbic and autonomic nervous systems is a major aspect of TRT. Counselling is also an essential component of treatment with TRT (Jastreboff, 1995). Patients with more troublesome tinnitus are advised to wear ear-level devices (sound generators) with TRT to optimize the habituation process. However, in TRT, sound generators are not given always and even if they are given, are not given to suppress the tinnitus completely. TRT patients are also advised to wear hearing aids if their hearing loss is considered a significant problem and to improve their communication ability (Jastreboff, 1995).

TRT has been proven to provide great relief to the patients suffering from chronic tinnitus (Henry et al., 2006). Though TRT is a structured management technique, this can only be carried-out by the audiologist who has undergone a formal training (Henry, Jastreboff, Jastreboff, Schechter & Fausti, 2002). In addition, TRT is time consuming.

Further, use of tinnitus maskers has also been found to suppress tinnitus (Quirk, Avinash, Nuttall & Miller, 1992; Folmer, Martin, Shi & Edlefsen, 2006). However, these instruments are generally recommended to be worn for several hours in a day and for several months together. Further, spectral output of these generators varies according to the different instruments, and the maximum output tends to span only about 2½ octaves and to occur within the frequency range between 1000 and 6000 Hz. This can be a disadvantage considering the fact that a broad band noise such as white noise is found to improve

[1]E-mail: 87great@gmail.com; [2]Lecturer in Audiology, E-mail: geethamysore.cs@gmail.com

tinnitus better than a narrow band signal. Further, these are also expensive and may not be affordable to many individuals; and not very cosmetically appealing, especially for individuals who do not require to wear hearing aids. Hence, an alternate to this could be providing white noise through an audiometer through the earphones without having to wear a ear level device all through the day.

Hence, the present study aimed to evaluate the effect of tinnitus masking, through an audiometer by delivering white noise to provide tinnitus masking therapy, in the clinical set up, through the earphones.

Music has also been found to be useful in treating tinnitus. Notched music therapy developed by Okamoto, Stracke, Stoll, & Pantev, (2010) is based on the notion that tinnitus is generated in the central auditory system, possibly due to maladaptive cortical reorganization. When the input from the peripheral system is decreased, auditory cortex neurons that are deprived of normal thalamo-cortical input (through MGB) become active. These neurons in turn rewire/synapse with excitatory inputs from neighbouring neurons. This change in synapse makes the neurons sensitive to neighbouring frequencies and, hence, maladaptively changing the tonotopic maps. These cortical areas may generate tinnitus by means of synchronized spontaneous neural activity (Mühlnickel, Elbert, Taub, & Flor, 1998). The notched music treatment strategy helps in the reversion of the maladaptive reorganization of a specific cortical area contributing to the perception of tinnitus and also reduces the tinnitus loudness (Okamoto et al., 2010).

This technique has proven to diminish the perception of tinnitus in persons with hearing loss. However, several individuals who have normal or near normal hearing sensitivity complain of clinically significant tinnitus and the mechanisms involved in the generation of tinnitus in these subjects are not clear.

Hence, the present study was taken up to evaluate the efficacy of two intervention procedures for tinnitus sufferers, Notched music therapy and White noise therapy using psychoacoustic measurement of tinnitus loudness using loudness matching procedure and Tinnitus Severity Index Questionnaire (TSIQ) given by Folmer (2002).

Method

Participants

Ten participants (4 males and 6 females) in age group of 20 to 60 years (mean age of 38.5 years) with clinically significant tinnitus were included in the study (Table 1). All subjects had chronic continuous tonal tinnitus and had either unilateral tinnitus (6 subjects) or bilateral tinnitus (4 subjects). The tinnitus frequency did not exceed 8 kHz and the subjects' hearing sensitivity was not greater than minimal hearing impairment (≤ 25 dB HL). All the subjects who participated in the study had partial or complete residual inhibition and no history of middle ear pathology, no history of neurological or psychiatric problems.

Participants who were willing to attend therapy were randomly assigned into two groups. First group receiving notched-music therapy and the Second group receiving white noise therapy.

Procedure

The entire evaluation and the therapy sessions were carried out in a double sound treated room, with the ambient noise levels within the permissible limits (as specified by ANSI S3.1-1991). The following procedure was adopted for the routine hearing evaluation and tinnitus evaluation.

Routine audiological evaluation

Routine audiological evaluation was carried out to track patients' air conduction thresholds from 250 Hz through 8 kHz and bone conduction thresholds from 250 Hz through 4 kHz at octave intervals. This was done through a calibrated Madsen Orbiter 922 diagnostic audiometer with TDH 39 supra aural earphones housed in MX-41/AR ear cushions. Speech audiometry was carried out to find their speech recognition threshold, speech identification scores and comfortable levels. Tympanometry and assessment of acoustic reflex thresholds were carried out to rule out any middle ear pathology and Eustachian tube dysfunction using Grason Stadler Inc. (GSI) Tympstar clinical immittance meter. ENT clearance was obtained for all participants prior to tinnitus evaluation.

Tinnitus evaluation

Case history: A detailed case history regarding their tinnitus was obtained prior to the assessment of tinnitus. This included the type of tinnitus (continuous/intermittent), nature of tinnitus, the onset of tinnitus, any associated events and lateralization of tinnitus, etc.

Psychophysical assessment of tinnitus: Pre-therapy assessment of tinnitus pitch and loudness were tracked using pitch matching and loudness matching respectively. This served as the baseline for the therapy. Following assessment procedure were adopted to track the pitch and loudness of tinnitus.

Table 1: Details of the participants of the present study

Subject no.	Age/ Gender	Pure tone average (dB HL)	
		Right	Left
1	24/F	8.3	0
2	20/F	8.3	8.3
3	49/M	10	10
4	50/M	16.6	11.6
5	24/F	6.6	6.6
6	48/F	16.6	13.3
7	45/F	18.3	25
8	60/ M	15	20
9	35/F	11.6	11.6
10	30/M	16.6	8.3
Mean	38.5	12.79	11.47

Pitch match: To track the appropriate tinnitus pitch, pure tone was presented (as all patients had tonal tinnitus) in successive, discrete steps. Initially a 1 kHz pure tone was presented at not more than 10 dB SL. This procedure was adopted from Henry (2006). In this procedure, the subjects were asked to indicate whether their tinnitus pitch is above or below the presented tone. Based on their response, the frequency was varied above or below 1 kHz at different octaves and at mid octaves. When the patient indicates that their tinnitus pitch was nearer, 3-Alternate Forced Choice (3-AFC) procedure was used to obtain exact pitch of the tinnitus and to avoid octave confusion. In this procedure, 3 pure tones of different frequencies were presented; 1) tone which was half-octave above the pitch matched, 2) tone which was same as the pitch matched by the patient and 3) tone which was half-octave below the matched pitch. Among the three tones the subject had to indicate the tone that was best matched to their tinnitus. The matched tinnitus pitch served as the basis for the music modification for notched music therapy.

In clients with unilateral tinnitus, the signal was presented to the ear opposite to the side where the tinnitus was perceived. In clients with bilateral tinnitus, the signal was presented to the ear with lesser threshold when the hearing sensitivity was asymmetrical (as all the participants with bilateral tinnitus reported of equal tinnitus loudness in both ears).

The tinnitus pitch was matched four times on two different days and the median across pitch matches was considered as the tinnitus frequency. This served as the basis for the music modification for notched music therapy.

Loudness match: Loudness match was carried out using balance technique. For this, frequency of the tone was same as the tinnitus pitch. The signal was varied in intensity in ascending technique till the patient first heard the signal. This level was taken as the threshold. Further, the signal level was increased in 5 dB steps till the subject indicated that it was equal in loudness with his/her tinnitus. The difference between the threshold and intensity of the reference signal was considered to be the tinnitus loudness, which was expressed in dB SL (Meikle, Henry & Mitchell, 1995). Evaluation of the tinnitus loudness was matched four times on two different days and the median across loudness matches was considered as the tinnitus loudness.

Residual Inhibition: Residual inhibition was done to see if there was any change in the tinnitus following the auditory stimulation. This was done using white noise which was presented bilaterally at 70 dB SPL. All the participants in the study had partial or complete inhibition of tinnitus.

Administration of questionnaire

For the pre- and post-therapy assessment of tinnitus severity, along with assessment of tinnitus loudness, Tinnitus Severity Index Questionnaire (TSIQ) was used. This questionnaire was given by Folmer (2002). This questionnaire constitutes of 12 items to assess patients' reaction to tinnitus and its interference. The response option for each item had 5 levels; never, rarely, sometimes, usually, always. TSIQ also constituted of rating the loudness of tinnitus perceived by the patient. Loudness rating was done on a 10 point rating scale, where 1 indicates that the tinnitus was very quiet and 10 indicates that the tinnitus was very loud. The TSIQ questionnaire scores varied between a minimum of 13 and a maximum of 65.

The questionnaire was administered to both the groups prior to the therapy and the scores were noted. This served as the baseline for assessing subjects' perception of tinnitus before the therapy. Post therapy administration of the questionnaire was also done during therapy (after 10 sessions) and post therapy (at the termination of the therapy).

Procedure for tinnitus therapy

Procedure for white noise therapy: For white noise therapy, Madsen Orbiter 922 diagnostic audiometer was used to generate and present white noise. The patients were comfortably seated and supra aural earphones (TDH-39) were placed. The white noise was presented to both the ears at 20 dB SL (Jastreboff, 1995). The therapy was carried out for the duration of 60 minutes per session. Each patient underwent therapy for 20 sessions.

Procedure for notched-music therapy: For notched music therapy, Indian instrumental music was chosen.

A total of 7 tracks were selected. These tracks were played twice for the duration of 60 minutes. Each track was filtered using Adobe Audition 3.0 software. Through this filter, a notch was created in the spectrum of music. The frequency of the notch was same as tinnitus pitch and the bandwidth of the notch was of one octave width. The same method was carried out for each track and later all the tracks were temporally aligned. The music delivered to both ears was filtered identically and was presented at 20 dBSL. This technique was adopted from Okamoto, et al. ,(2010).

Therapy was a passive listening task and the subjects were made to read a newspaper or a novel during the therapy session. Each subject underwent therapy for 20 sessions.

Consecutive evaluation of tinnitus pitch and loudness along with administration of Tinnitus severity index questionnaire were carried out during the course of the therapy (after 10 sessions) and at the termination of therapy (after 20 sessions) for both the groups of participants. The loudness of the perceived tinnitus and the questionnaire scores across the three therapy conditions were taken for further analysis. To see if the effects of therapy were present even after withdrawing the therapy, patients were telephoned to ask if there was any change in the tinnitus after 15 days following the therapy.

Results

The study aimed to evaluate the benefit from White noise therapy and Tailor-made Notched music therapy which are two intervention procedures to treat tinnitus. For evaluating the efficacy of two therapy techniques, the measures considered were: Psychoacoustic measurement of loudness of tinnitus measured trough loudness matching procedure, which is hereafter referred as tinnitus loudness, and Tinnitus Severity Index Questionnaire (TSIQ) scores.

The pre- and post-tinnitus loudness measured across three intervals, that is, pre therapy, post-therapy-after 10 sessions, post-therapy after 20 sessions, using loudness matching and the Tinnitus Severity Index Questionnaire scores for the two groups were analysed using Statistical Package for the Social Sciences (SPSS for windows, Version 18) software.

The efficacy of notched music therapy

Evaluation of loudness measures: Five individuals (2 males & 3 females) with chronic continuous tinnitus underwent Notched Music therapy. Prior to the therapy, tinnitus evaluation was carried-out for all participants. Results of pre-therapy tinnitus evaluation for each subject who received Notched music therapy are given in the Table 2.

It can be observed from the Table 2 that the tinnitus loudness has reduced for three subjects after therapy, whereas, two of the subjects (Subject 1 & Subject 4) had complete inhibition of tinnitus. Hence, during the statistical analysis of post-therapy data, only data from three subjects were considered. Friedman's test was used to evaluate the benefit of notched music therapy.

Table 3 shows the mean and standard deviation of tinnitus loudness for Notched music therapy. As it can be seen in the table, there was decrease in the tinnitus loudness as the therapy progressed. To investigate whether this change was significant, Wilcoxon Signed Rank test was carried-out. The results of this are given in Table 4.

As it can be seen in the Table 4, there was a significant difference ($p<0.05$) between the tinnitus loudness measured at baseline and after 10 therapy sessions. However, no significant difference ($p>0.05$) was seen between baseline and after 20 sessions and between two post therapy conditions (10 sessions & 20 sessions). This may be because; two of the subjects could not match tinnitus loudness as there was no tinnitus after the termination of therapy. However, subjective analysis of individual data revealed a difference in the tinnitus loudness for all subjects who received Notched music therapy.

Table 2: Details of tinnitus evaluation of subjects who underwent notched music therapy

Subject No.	Matched Tinnitus pitch (in Hz)	Matched tinnitus loudness (in dB SL)		
		Pre therapy	Post therapy (after 10 sessions)	Post therapy (after 20 sessions)
1	8000	40	20	Complete inhibition of tinnitus
2	3000	40	25	0
3	8000	40	25	15
4	4000	20	10	Complete inhibition of tinnitus
5	8000	45	30	15

Table 3: Mean and SD of tinnitus loudness across three intervals for Notched music therapy

Conditions	Number of subjects	Mean	SD
Pre therapy	5	37.00	9.747
Post therapy (after 10 sessions)	5	22.00	7.583
Post therapy (after 20 sessions)	3[#]	8.33	7.638

[#] *- Two of the five subjects had complete inhibition of tinnitus. Hence, tinnitus loudness could be measured only for three participants*

Table 4: Results of Wilcoxon Signed Rank test for tinnitus loudness measure for notched music therapy

Conditions	z- value
Pre and post-therapy (10)	-2.060*
Pre and post-therapy (20)	-1.604
Post therapy (10) and Post therapy (20)	-1.604

*Note. *p<0.05*

Evaluation on Questionnaire scores

Mean and standard deviation of TSIQ scores across the three therapy intervals for subjects who underwent Notched music therapy is given in Table 5. It can be observed that the questionnaire scores decreased after therapy (10 sessions & 20 sessions) when compared to the baseline questionnaire scores.

Wilcoxon Signed Rank test was carried-out to investigate the questionnaire scores across three intervals. Results of Wilcoxon Signed Rank test are shown in Table 6.

Table 6 shows that there is a significant difference in the questionnaire scores between pre therapy and between the two post therapy conditions ($p<0.05$).

Table 5: Mean and SD of questionnaire scores across three intervals for Notched music therapy

Conditions	No. of subjects	Mean	SD
Pre therapy	5	33.40	6.229
Post therapy (after 10 sessions)	5	23.20	5.167
Post therapy (after 20 sessions)	5	15.40	2.608

Table 6: Results of Wilcoxon Signed Rank test for questionnaire for notched music therapy

Conditions	z- value
Pre and Post therapy (10)	-2.032*
Pre and Post therapy (20)	-2.023*
Post therapy (10) and Post therapy (20)	-2.023*

*Note. *p <0.05*

The efficacy of white noise therapy

Evaluation on loudness measures: Five participants (2 males & 3 females) with chronic tinnitus underwent White noise therapy. Results of pre-therapy tinnitus evaluation for each subject who received White noise therapy are given in the Table 7.

It can be observed from the Table 7 that the loudness of the tinnitus perceived reduced after therapy as compared to pre therapy. Mean and SD of tinnitus loudness matched across the three intervals are given in the Table 8.

To investigate whether this change was significant, Wilcoxon Signed Rank test was carried out. The results of this are given in Table 9.

Table 7: Details of tinnitus evaluation of subjects who underwent White noise therapy

Subject no.	Matched pitch (in Hz)	Matched tinnitus loudness (in dB SL)		
		Pre therapy	Post therapy (after 10 sessions)	Post therapy (after 20 sessions)
1	125	30	20	5
2	4000	35	25	10
3	3000	25	15	0
4	125	40	20	0
5	1000	30	20	5

Table 8: Mean and SD of tinnitus loudness across three intervals for White noise therapy

Conditions	No. of subjects	Mean	SD
Pre-therapy	5	32.00	5.701
Post-therapy (after 10 sessions)	5	20.00	3.536
Post-therapy (after 20 sessions)	5	4.00	4.183

Table 9: Results of Wilcoxon Signed Rank test for tinnitus loudness measure for White noise therapy

Conditions	z- value
Pre and post-therapy (10)	-2.121*
Pre and post-therapy (20)	-2.121*
Post-therapy (10) and post-therapy (20)	-2.121*

Note.*p<0.05

From the Table 9, it can be inferred that there is a significant difference (p<0.05) between the baseline and after 10 sessions, between baseline and after 20 sessions and between 10 sessions and 20 sessions post therapy.

Evaluation on questionnaire scores

Mean and standard deviation of TSIQ scores across the three therapy intervals for subjects who underwent White noise therapy is given in Table 10. It can be seen from the table that the questionnaire scores decreased after therapy (10 sessions & 20 sessions).

Wilcoxon Signed Rank test was carried out to investigate the questionnaire scores across three therapy intervals and the results of Wilcoxon Signed Rank test are shown in Table 11.

Table 10: Mean and SD of questionnaire scores across three intervals for White noise therapy

Conditions	Number of subjects	Mean	SD
Pre-therapy	5	42.80	6.380
Post-therapy (after 10 sessions)	5	30.60	6.731
Post-therapy (after 20 sessions)	5	17.00	2.345

Table 11: Results of Wilcoxon Signed Rank test for questionnaire for White noise therapy

Conditions	z- value
Pre and post-therapy (10)	-2.023*
Pre and post-therapy (20)	-2.023*
Post-therapy (10) and post-therapy (20)	-2.023*

Note. *p <0.05

From the Table 11, it is clear that there is a significant difference in the questionnaire scores between pre therapy and between two post therapy conditions (p<0.05).

Comparison between the Notched music therapy and White noise therapy

Mann Whitney U test was carried out to compare the benefit obtained between the two therapy procedures for tinnitus loudness and questionnaire scores across the therapy intervals. Results of the Mann Whitney U test are given in the Table 12 and Table 13.

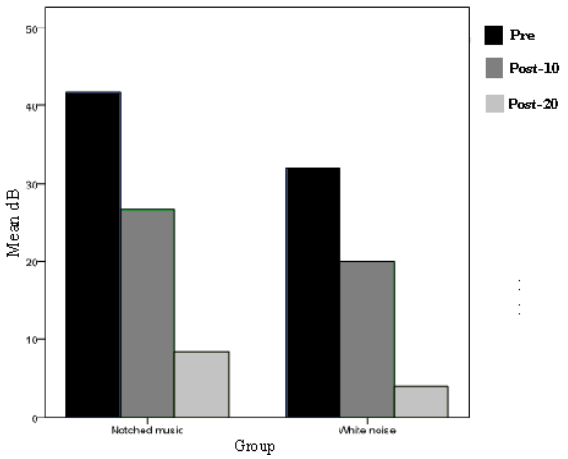

Figure1: Loudness measured pre-therapy, post therapy after 10 sessions and 20 sessions for both the therapy groups

Table 12: Results of Mann Whitney U test for Notched music and White noise therapy for tinnitus loudness

Conditions	No of subjects	Mean (SD) dBSL	Mann Whitney U value	z	p
Pre therapy	10	34.50 (7.976)	6.500	-1.297	0.195
Post therapy (after 10 sessions)	10	21.00 (5.676)	8.500	-0.873	0.382
Post therapy (after 20 sessions)	8	5.63 (5.630)	4.500	-0.928	0.353

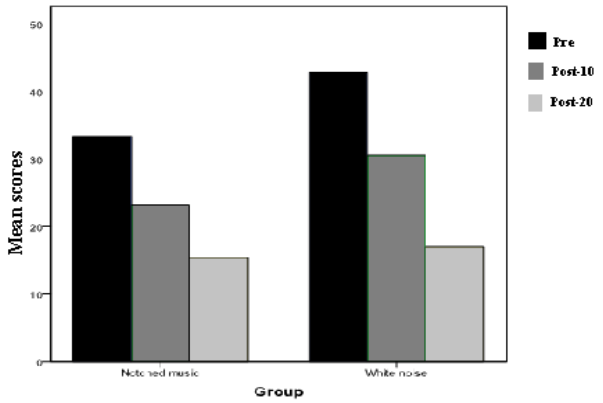

Figure 2: Questionnaire scores pre-therapy, post therapy after 10 sessions and 20 sessions for both the therapy groups

Table 13: Results of Mann Whitney U test for Notched music and White noise therapy for questionnaire scores

Conditions	No. of subjects	Mean (SD)	Mann Whitney U value	z	P’
Pre therapy	10	38.10 (7.738)	3.500	-1.886	0.059
Post therapy (after 10 sessions)	10	26.90 (6.871)	6.000	-1.362	0.173
Post therapy (after 20 sessions)	10	16.20 (2.486)	7.500	-1.640	0.287

It is clear from the Table 12 and Table 13 that there is no statistically significant difference ($p>0.05$) between the two therapy techniques for tinnitus loudness and the questionnaire scores. However, on subjective analysis of individual data there was a difference in the tinnitus loudness and questionnaire scores between the two techniques. The subjects receiving Notched music therapy had greater improvement and two of the five subjects receiving Notched music therapy reported complete inhibition of tinnitus.

To see if the effects of therapy were present even after withdrawing the therapy, patients were telephoned to ask if there was any change in the tinnitus after 15 days following the therapy. None of the subjects reported of any change in the tinnitus loudness after 15 days of withdrawal of therapy.

Discussion

The results obtained from different statistical analysis for psychoacoustic measure of tinnitus loudness and questionnaire scores for both the therapy techniques are discussed below.

Efficacy of notched music therapy using psychoacoustic measurement of tinnitus loudness and questionnaire scores

Results of comparison of pre therapy and post therapy psychoacoustic measurement of tinnitus loudness and

questionnaire scores showed decrease in the loudness at the termination of therapy in three subjects. Whereas, two had a complete inhibition of tinnitus which indicates that the therapy was successful in ameliorating tinnitus completely.

The above mentioned observation is in support of the notion that tinnitus loudness can be significantly diminished by custom tailored notched music treatment (Okamoto, et al., 2010). Tailor-made notched music treatment strategy helps in complete suppression of tinnitus by reorganizing the maladaptive auditory cortex (Rauschecker, 1995; Blood & Zatorre, 2001; Elbert & Rockstroh, 2004) even in subjects with normal/near normal hearing sensitivity. In Okamoto et al. (2010), the therapy using the tailor-made notched music treatment was given over a period of 12 months. However, in the present study, only with 20 hours of therapy, there was an improvement seen. This could be attributed to the peripheral loss that the subjects in Okamoto, et al's study had, which might have led to more maladaptive cortical reorganization.

Pantev, Wollbrink, Roberts, Engelien and Lütkenhöner, (1999) demonstrated that listening to notched music reduces the cortical activity corresponding to the notch centre frequency, which may be due to the lateral inhibition. The target notched music introduces a functional deafferentation of auditory neurons corresponding to the eliminated frequency band, and because this frequency band overlaps the individual tinnitus frequency, the notched music no longer stimulates the cortical area corresponding to the tinnitus frequency, although it still excites surrounding neurons. Thus, the neurons which were not stimulated due to the notch were presumably actively suppressed via lateral inhibitory inputs originating from surrounding neurons (Pantev, et al., 1999; Pantev, et al., 2004; Okamoto, Kakigi, Gunji & Pantev, 2007).

Efficacy of White noise therapy using tinnitus loudness and questionnaire scores

Similar to the results of Notched-music therapy, results of comparison of pre- and post-therapy psychoacoustic measurement of tinnitus loudness and questionnaire scores also showed decrease in the loudness at the termination of White noise therapy in all the subjects. However, none of the subjects showed complete inhibition. This result is in correlation with the earlier studies that used broadband noise generators for the masking of tinnitus (Henry, et al., 2006; Vernon & Schleuning, 1978; Henry & Meikle, 2000; Kitajima, Kitahara & Kodama, 1987; Shailer, Tyler & Coles, 1981). Hence, white noise therapy given in a clinical set-up is useful at least to suppress the tinnitus. This therapy has an advantage over the noise generators, which are take home devices and have to be worn all the time.

Comparison between the Notched music therapy and White noise therapy

The comparison between the two therapies revealed no statistical significant difference which may be because only data from three subjects receiving Notched music therapy were considered for analysis. However, subjective analysis of individual data revealed a difference in the tinnitus loudness and questionnaire scores. This revealed that subjects receiving Notched music therapy showed greater improvement when compared to White noise therapy. Hence, Notched-music which is tailor made for each subject, might be a better option to treat tinnitus when compared to White noise.

Conclusions

It can be concluded that both the therapy techniques provide significant benefit in suppressing tinnitus. Hence, white noise therapy in a clinical set up can be considered as an option of tinnitus treatment at least to suppress the tinnitus, to some extent. It can also be concluded that even tinnitus subjects who have near normal hearing sensitivity have maladaptive cortical reorganization which can be corrected with tailor made notched-music therapy. Further, notched music therapy was found to provide more benefit than white noise therapy, though this difference was not statistically significant.

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