Am J Otolaryngol 40 (2019) 253–256

Contents lists available at ScienceDirect

Am J Otolaryngol

journal homepage: www.elsevier.com/locate/amjoto

Clinical efficacy of cognitive behavioral therapy for chronic subjective tinnitus

Juan Li*, Jianhua Jin, Songli Xi, Qian Zhu, Yuqin Chen, Min Huang, Chunyan He

Department of Otorhinolaryngology, Shanghai Tongren Hospital Affiliated to Shanghai Jiaotong University School of Medicine, Shanghai 200336, China

ARTICLE INFO

Keywords:
Chronic subjective tinnitus
Cognitive behavioral therapy
Efficacy

ABSTRACT

Background: Although cognitive behavioral therapy (CBT) has been known with a theoretical basis for tinnitus patients, there still were lack of clinical evidence.
Objective: To evaluate the clinical efficacy of cognitive behavioral therapy (CBT) for treatment of chronic subjective tinnitus.
Methods: One hundred patients with chronic subjective tinnitus patients were randomly divided into control (50 cases) and intervention (50 cases) groups, which received the masking therapy and sound treatment and masking therapy and sound treatment plus CBT. The treatment efficacy was evaluated.
Results: The total effective rate in intervention group was significantly higher than control group ($P < 0.01$). After treatment, compared with control group, in intervention group the psychotic somatization, interpersonal sensitivity, depression, anxiety, hostility, terror, and phobic anxiety scores in Symptom Checklist-90 and Tinnitus Handicap Inventory score were significantly decreased ($P < 0.05$), the serum cortisol level was significantly decreased ($P < 0.05$), and the serum interleukin-2 level was significantly increased ($P < 0.05$).
Conclusion: Based on the elimination the mood disorders and reduce the stress, CBT can significantly relieve the symptoms of chronic subjective tinnitus.

1. Introduction

Subjective tinnitus is the subjective perception of hearing which is not caused by external voice or electrical stimulation [1]. It is often accompanied by hearing loss, auditory hypersensitivity, fatigue, stress, distraction, anxiety, depression or other symptoms [2]. Recent epidemiological studies have shown that, there are 13%–18% populations with tinnitus sensation. In the elderly, the incidence of tinnitus is up to 33%. There are 4%–5% patients receiving treatment due to tinnitus [3]. Many factors can lead to tinnitus, including Meniere's disease, sudden deafness, noise, and psychological factors. The role of psychological factors in the development of tinnitus has attracted more and more attention [4]. Tinnitus is often accompanied by deafness, but tinnitus can cause more pain than deafness, which not only affects the normal work, study and life, but ultimately cause serious psychological disorders and even suicide [5]. As early as 1997, Jastreboff et al. [6] proposed the neuropsychological model of tinnitus production mechanism, which has provided a theoretical basis for the study and understanding of cognitive behavioral therapy (CBT) for tinnitus patients. This treatment model emphasizes the correlation of subjective tinnitus with excessive spontaneous electrical activity in the auditory center [7]. The activity of the autonomic nervous system may be affected by the limbic system and cerebral cortex, which in turn affects the activity of the cerebral cortex and the limbic system, thus indirectly impacting the psychological feelings of patients [8]. There are many treatment schemes for tinnitus, but lacking of effective drugs and methods. With the development of society, fast-paced and high-intensity workload and evolution of social relationships, people are more prone to certain mental disorders [9]. CBT belongs to the psychotherapy, in which the cognitive therapy and behavioral therapy are applied to modify the inappropriate cognitive behavior [10]. In this study, CBT was applied to intervene to the chronic subjective tinnitus, and the treatment efficacy was evaluated. The objective was to provide a reference for the further application of CBT for treatment of chronic subjective tinnitus.

2. Materials and methods

2.1. Patients

One hundred patients with chronic subjective tinnitus receiving

* Corresponding author at: Department of Otorhinolaryngology, Shanghai Tongren Hospital Affiliated to Shanghai Jiaotong University School of Medicine, No. 1111 Xianxia Road, Changning District, Shanghai 200336, China.
E-mail address: juanlidoc@126.com (J. Li).

https://doi.org/10.1016/j.amjoto.2018.10.017
Received 24 October 2018

treatment from September 2013 to March 2016 in our hospital were enrolled in this study. There were 59 males and 41 females. The age of patients was 18–83 years, with mean age of 43.22 ± 4.32 years. The disease course was 0.3–10 years, with mean of 2.52 ± 0.72 years. The inclusion criteria were as follows: the patients had persistent tinnitus or had nocturnal tinnitus symptoms for > 3 months, and had the negative mental mood, such as fidgety and irritability. The exclusion criteria were as follows: i) obvious local and systemic acute inflammation; ii) tumor history; iii) obvious metabolic diseases; iv) obvious systemic immune diseases; v) serious medical illness; vi) ear surgery related diseases. The patients were randomly divided into control and intervention groups, 50 cases in each group. This study was conducted in accordance with the declaration of Helsinki, and was approved by the ethics committee of Shanghai Tongren Hospital Affiliated to Shanghai Jiaotong University School of Medicine. Written informed consent was obtained from all participants.

2.2. Treatment in control group

Control group received the masking therapy and sound treatment using TinniTest tinnitus treatment system (Wendy Digital Technology Co., Ltd., Chengdu, China) as follows: i) The tinnitus information, hearing test results, tinnitus test results and sound treatment course of each patient were recorded. ii) The tinnitus test was performed, which included tinnitus sound type, frequency and loudness test, Feldmann masking curve setting, octave confusion test, minimum masking threshold test, masking audiogram, residual suppression or masking effect test masking ability test. Finally, the tinnitus test data combined with hearing test data were analyzed. iii) After completion of hearing test and tinnitus test, the masking treatment program was generated based on the accurate testing and matching data, which included the pure tone, white noise, warble tone, natural sound, music, narrowband noise, sound environment, etc. These sounds were overlaid by appropriate light music, and were directly output to the Tinni Test masker. Under the assistance of doctors and nurses, the patient selected the minimum effective masking volume. The patient focused on the music, relaxing the vigilance to tinnitus masking. Thus, the patient gradually adapted the tinnitus, and the tinnitus was reduced or eliminated. The masking therapy was performed for 30 min, once a day. During the treatment, if some patients reported the drifting of main tinnitus pitch, the composite masking sound was changed for matching. The treatment was performed for 6 months.

2.3. Treatment in intervention group

Intervention group received the masking therapy and sound treatment plus CBT for psychological intervention, twice a week. The treatment paths included three steps including cognitive restructuring, problem solving and sound treatment (sensory desensitization) [11]. The individualized treatment plan was applied in actual operation based on the patient-specific circumstances. i) Cognitive restructuring: firstly, the doctors and nurses obtained the trust and cooperation of patients, for building a harmonious doctor-patient and nurse-patient relationship. The doctors and nurses patiently listened to the patient's worries and concerns, and contrapuntally answered the questions. The patients were helped to understand the occurrence and development of tinnitus through personal conversation and propaganda and education. The right expectation and treatment confidence were established, and the negative emotions were eliminated. The virtuous cycle between psychological factors and tinnitus was established. Then, according to the patient's character, hobby and cultural degree, the specific psychological counseling measures including conversation, consolation, doubt dispelling and encouragement were taken, to help patients change their thinking mode and negative attitude and learn the emotional self-regulation. The family members of patients were encouraged to strengthen communication and understanding and cooperation with patients. The friends were introduced to the patients, for creating a good family-social relationship. ii) Problem solving: the patients were encouraged to actively participate in the normal working, living and learning, and participate in recreational activities in spare time. The patients were encouraged to participate in appropriate physical exercise to enhance physical fitness and divert the attention to tinnitus. However, it was necessary to avoid contact with noisy environment so as not to aggravate the tinnitus. For patients difficult to fall asleep due to tinnitus, they were instructed to play relaxing and relaxing music in bedroom before falling asleep, but the earplugs wearing was forbidden to avoid aggravating hearing loss. The patients were guided to lie on the bed and relax with order of head, neck, shoulder, arm, chest, abdomen, buttocks, leg and feet [9]. The patients were guided to dilute the focus on tinnitus, relax the vigilance to tinnitus, and reach the sensory adaptation of tinnitus. For patients with different tinnitus, the individual counseling treatment was added depending on the specific characteristics, for relieving the psychological confusion and misunderstandings of tinnitus. iii) Masking therapy and sound treatment: the treatment scheme in intervention group was the same with that in control group. The treatment was performed for 6 months.

2.4. Evaluation of total treatment efficacy

Total treatment efficacy was evaluated before and after treatment. According to the reported methods [12], the severity of tinnitus was divided into grade I–V from light to heavy. The total treatment efficacy was evaluated as follows: i) cured: the tinnitus and accompanied symptoms disappeared, with no recurrence in follow up for 1 month; ii) markedly effective: the tinnitus degree was reduced by no < 2 grades; iii) effective: the tinnitus degree was reduced by 2 grade; iv) ineffective: there was no change in tinnitus.

2.5. Symptom Checklist-90 scale

Symptom Checklist (SCL-90) was used for measurement and evaluation [13] This list included 90 items, which were divided into 9 symptom clusters including psychotic somatization (F1), obsessive-compulsive symptoms (F2), interpersonal sensitivity (F3), depression (F4), anxiety (F5), hostility (F6), terror (F7), phobic anxiety (F8), and psychoticism (F9). The severity of symptoms was graded with 1–5 scores. The item of the scale is assessed in reference to how much discomfort there is of the particular problem. This scale can access the psychological symptoms of the patients.

2.6. Tinnitus Handicap Inventory scale

Tinnitus Handicap Inventory (THI) [14] scale was used to evaluate the life quality and therapy efficacy. This scale had 25 items, including 11 functional scores, 9 emotional scores, and 5 scores. The patients were guided to answer “yes”, “no” or “sometimes”, which meant frequent occurrence (4 points), no occurrence (0 point) and occasional occurrence (2 points), respectively. The scores of different items were calculated by plus, and the average score was obtained.

2.7. Determination of cellular immunity related indexes

On the morning before and after treatment, 5 ml peripheral venous blood was taken from the patients. The serum levels of cortisol (Cor) and interleukin-2 (IL-2) were detected using enzyme linked immunosorbent assay.

2.8. Statistical analysis

All statistical analysis was carried out using SPSS19.0 software (SPSS Inc., Chicago, IL, USA). The enumeration data were presented as number and rate, and were compared using χ^2 test. The measurement

Table 1
Comparison of general data between two groups.

Index	Control group	Intervention group	t/χ2	P
n	50	50		
Age (years)	42.66 ± 3.72	43.81 ± 4.12	−1.461	0.147
Gender (male, n)	28	31	0.206	0.650
Disease course (years)	2.47 ± 0.56	2.59 ± 0.41	−1.223	0.224
Number of affected ear (n)			0.364	0.546
One	26	29		
Two	24	21		
Tinnitus type			0.220	0.896
High-frequency tinnitus	21	22		
Low-frequency tinnitus	16	17		
Mixed tinnitus	13	11		

data were presented as mean ± SD, and were compared using *t*-test. $P < 0.05$ was considered as statistically significant.

3. Results

3.1. Comparison of general data

General data of patients in two groups were shown in Table 1. There was significant difference in age, gender, disease course, number of affected ear, or tinnitus type between two groups ($P > 0.05$).

3.2. Comparison of total treatment efficacy

Table 2 showed that, after treatment, there 3, 8, 21 and 18 cases with cured, markedly effective, effective and ineffective outcome in control group, respectively, with 7, 15, 25 and 3 cases with cured, markedly effective, effective and ineffective outcome in intervention group, respectively. The total effective rate in intervention group was 96.00%, which was significantly higher than 64.00% in control group ($P < 0.01$).

3.3. Comparison of SCL-90 scores

As shown in Table 3, before treatment, there was no significant difference of each item score of SCL-90 between two groups ($P > 0.05$). After treatment, the F3 and F6 scores in control group were significantly lower than those before treatment, respectively ($P < 0.05$). After treatment, the F1, F3, F4, F5, F6, F7 and F8 scores in intervention group were significantly lower than those before treatment, respectively ($P < 0.05$), and were significantly lower than those in control group, respectively ($P < 0.05$).

3.4. Comparison of THI scores

Table 4 showed that, before treatment, there was no significant difference in THI score between two groups ($P > 0.05$). After treatment, the THI score in each group was significantly lower than that before treatment ($P < 0.05$), and that in group was significantly lower than that in control group ($P < 0.05$).

Table 2
Comparison of total treatment efficacy between two groups [n (%)].

Group	n	Cured	Markedly effective	Effective	Ineffective	Effective rate (%)
Control	50	3(6.00)	8(16.00)	21(42.00)	18(36.00)	64.00
Intervention	50	7(14.00)	15(30.00)	25(50.00)	3(6.00)	94.00
χ2		13.562				
P		< 0.01				

Table 3
Comparison of SCL-90 scores between two groups.

Item	Control group (n = 50)		Intervention group (n = 50)	
	Before treatment	After treatment	Before treatment	After treatment
F1	2.52 ± 0.45	2.47 ± 0.43	2.46 ± 0.47	1.81 ± 0.44*#
F2	1.97 ± 0.64	1.89 ± 0.51	1.91 ± 0.62	1.88 ± 0.55
F3	2.03 ± 0.69	1.79 ± 0.44*	1.96 ± 0.63	1.52 ± 0.69*#
F4	2.55 ± 0.67	2.42 ± 0.71	2.48 ± 0.61	2.12 ± 0.63*#
F5	2.89 ± 0.52	2.73 ± 0.53	2.82 ± 0.58	1.95 ± 0.56*#
F6	1.78 ± 0.52	1.55 ± 0.56*	1.81 ± 0.56	1.33 ± 0.41*#
F7	1.63 ± 0.51	1.59 ± 0.41	1.68 ± 0.46	1.41 ± 0.36*#
F8	1.48 ± 0.56	1.43 ± 0.59	1.41 ± 0.52	1.16 ± 0.54*#
F9	1.32 ± 0.46	1.32 ± 0.43	1.35 ± 0.42	1.37 ± 0.46

SCL-90, Symptom Checklist-90; F1, psychotic somatization; F2, obsessive-compulsive symptoms; F3, interpersonal sensitivity; F4, depression; F5, anxiety; F6, hostility; F7, terror; F8, phobic anxiety; F9, psychoticism.
* $P < 0.05$ compared with before treatment.
# $P < 0.05$ compared with control group.

Table 4
Comparison of THI scores between two groups.

Group	Before treatment	After treatment
Control (n = 50)	58.78 ± 11.36	48.72 ± 9.04*
Intervention (n = 50)	57.26 ± 10.48	35.78 ± 8.21*#

THI, Tinnitus Handicap Inventory.
* $P < 0.05$ compared with before treatment.
# $P < 0.05$ compared with control group.

3.5. Comparison of serum Cor and IL-2 levels

As shown in Table 5, before treatment, there was no significant difference of serum Cor or IL-2 level between control and intervention group ($P > 0.05$). After treatment, the serum Cor level in each group was significantly lower than that before treatment ($P < 0.05$), and the IL-2 level was significantly higher than that before treatment ($P < 0.05$). In addition, after treatment, the Cor level in intervention group was significantly lower than that in control group ($P < 0.05$), and the IL-2 level in intervention group was significantly higher than that in control group ($P < 0.05$).

4. Discussion

CBT is a new psychotherapy method. From the cognitive perspective, CBT intervenes with the patients with cognitive behavior disorder by applying cognitive theory, ABC theory and behaviorist theory and methods. This therapy is based on the theoretical hypothesis that the cognitive process can affect the emotion and behavior. It can change the bad cognition of patients through cognitive intervention and behavioral techniques, and emotional management [15]. CBT is originally applied to treat depression, anxiety, insomnia and chronic pain. At present, the treatment of tinnitus itself is still lack of acknowledged effective method. A large number of studies have confirmed that, control of the anxiety emotion can mitigate the symptoms of tinnitus patients [16]. The target of tinnitus treatment is not to completely cover or remove the tinnitus sound, but to take some intervention measures to make the patients to be less concerned about their tinnitus, and understand and effectively control the tinnitus related problems.

This study applied CBT to intervene the chronic subjective tinnitus. Results showed that, the effective rate in intervention group was significantly higher than that in control group ($P < 0.01$); after treatment, the F1, F3, F4, F5, F6, F7 and F8 scores and THI score in intervention group were significantly lower than those in control group,

Table 5
Comparison of serum Cor and IL-2 levels between two groups.

Index	Control group (n = 50)		Intervention group (n = 50)	
	Before treatment	After treatment	Before treatment	After treatment
Cor (ng/ml)	424.43 ± 50.89	328.45 ± 44.10*	406.33 ± 52.91	246.99 ± 45.11*#
IL-2 (ng/ml)	12.40 ± 2.65	16.34 ± 3.06*	13.01 ± 3.04	18.49 ± 4.11*#

Cor, cortisol; IL-2, interleukin-2.
* $P < 0.05$ compared with before nursing.
# $P < 0.05$ compared with control group.

respectively ($P < 0.05$). This indicates that, CBT can make the patients to actively participate in emotional management, effectively relieve the negative emotion, improve the treatment confidence, reduce the attention to the tinnitus, thus and improving the therapeutic effect.

Immunosuppressive factors produced by stress have a parallel relationship with the resistance of the body. They can reflect the changes of the body's resistance, and are the material basis for the decrease of immune function and the decline of body resistance [17] Cor is a hormone secreted by the adrenal cortex. It affects the function of tissues and organs and the metabolism of glucose, fat and protein. In the stress condition, Cor activates the hypothalamic-pituitary-adrenal axis, and perturbs the endocrine system of body. It is an objective indicator for measuring the stress level of body [18]. Cor can decrease the blood lymphocytes, and reduce the activities of mononuclear cells and T lymphocytes, thus exerting the immunosuppressive effects [19]. IL-2 is a cytokine which plays an important role in the regulation of cellular immunity. It can stimulate the NK cells, and induce the proliferation of T lymphocytes, thus exerting the anti-tumor and anti-infection effects [20]. In this study, serum Cor and IL-2 levels of patients before and after treatment were detected. After treatment, compared with control group, in intervention group the Cor level was significantly decreased ($P < 0.05$), and the IL-2 level was significantly increased ($P < 0.05$). This indicates that, CBT can alleviate the depression and anxiety in chronic subjective tinnitus patients, thus improving the treatment effect.

5. Conclusion

Treatment of tinnitus is still a difficult problem. Any methods only aiming at tinnitus symptoms but ignoring the cause cannot obtain good results. Therefore, the application of combination therapy is a trend for treatment of tinnitus. CBT mainly performs the cognitive remediation and reconstruction of adverse cognitive model, for eliminating the mood disorders and improving tinnitus adaptability. Undoubtedly, CBT is a promising and noteworthy treatment method for chronic subjective tinnitus.

Conflicts of interest

The authors declare no conflicts of interest.

Acknowledgements

This work was supported in part by the Health Planning Committee Fund of Shanghai Changning District (No. 20124Y01002).

References

[1] Clarke NA, Akeroyd MA, Henshaw H, Hoare DJ. Association between subjective tinnitus and cognitive performance: protocol for systematic review and meta-analysis. BMJ Open 2018;8(8):e023700https://doi.org/10.1136/bmjopen-2018-023700.
[2] Langguth B, Elgoyhen AB, Cederroth CR. Therapeutic approaches to the treatment of tinnitus. Annu Rev Pharmacol Toxicol 2018. https://doi.org/10.1146/annurev-pharmtox-010818-021556.
[3] Cima RF, Maes IH, Joore MA, Scheyen DJ. Specialised treatment based on cognitive behaviour therapy versus usual care for tinnitus: a randomised controlled trial. Lancet 2012;379(9830):1951–9. https://doi.org/10.1016/S0140-6736(12)60469-3.
[4] Trevis KJ, McLachlan NM, Wilson SJ. A systematic review and meta-analysis of psychological functioning in chronic tinnitus. Clin Psychol Rev 2018;60:62–86. https://doi.org/10.1016/j.cpr.2017.12.006.
[5] Molini E, Faralli M, Calzolaro L, Ricci G. Impact of identifying factors which trigger bothersome tinnitus on the treatment outcome in tinnitus retraining therapy. ORL J Otorhinolaryngol Relat Spec 2014;76(2):81–8. https://doi.org/10.1159/000360994.
[6] Jastreboff PJ, Gray WC, Gold SM. Neurophysiological approach to tinnitus patients. Am J Otol 1997;18(2):265–6.
[7] Ramirez RR, Kopell BH, Butson CR, Gaggl W, Friedland DR, Baillet S. Neuromagnetic source imaging of abnormal spontaneous activity in tinnitus patient modulated by electrical cortical stimulation. Conf Proc IEEE Eng Med Biol Soc 2009;2009:1940–4. https://doi.org/10.1109/IEMBS.2009.5333457.
[8] Seydel C, Haupt H, Szczepek AJ, Klapp BF, Mazurek B. Long-term improvement in tinnitus after modified tinnitus retraining therapy enhanced by a variety of psychological approaches. Audiol Neurootol 2010;15(2):69–80. https://doi.org/10.1159/000231632.
[9] Gudwani S, Munjal SK, Panda NK, Kohli A. Association of chronic subjective tinnitus with neuro- cognitive performance. Int Tinnitus J 2017;21(2):90–7. https://doi.org/10.5935/0946-5448.20170018.
[10] Cima RFF. Bothersome tinnitus: cognitive behavioral perspectives. HNO 2018;66(5):369–74. https://doi.org/10.1007/s00106-018-0502-9.
[11] Koizumi T, Nishimura T, Sakaguchi T, Okamoto M, Hosoi H. Estimation of factors influencing the results of tinnitus retraining therapy. Acta Otolaryngol Suppl 2009;562:40–5. https://doi.org/10.1080/00016480902933072.
[12] Liu MJ, Xu MJ, Zhang YY. Electroacupuncture combined with auricular acupressure in the treatment of nervous tinnitus. World J Acupunct Moxibustion 2015;25(4):11–4. https://doi.org/10.1016/S1003-5257(17)30074-0.
[13] Lynn SG, Bauch CD, Williams DE, Beatty CW, Mellon MW, Weaver AL. Psychologic profile of tinnitus patients using the SCL-90-R and tinnitus handicap inventory. Otol Neurotol 2003;24(6):878–81. https://doi.org/10.1097/00129492-200311000-00009.
[14] Park SN, Bae SC, Kim DK, Park YS, Yeo SW, Park SY. Small-group counseling in a modified tinnitus retraining therapy for chronic tinnitus. Clin Exp Otorhinolaryngol 2013;6(4):214–8. https://doi.org/10.3342/ceo.2013.6.4.214.
[15] Kim BJ, Chung SW, Jung JY, Suh MW. Effect of different sounds on the treatment outcome of tinnitus retraining therapy. Clin Exp Otorhinolaryngol 2014;7(2):87–93. https://doi.org/10.3342/ceo.2014.7.2.87.
[16] Durai M, Searchfield G. Anxiety and depression, personality traits relevant to tinnitus: a scoping review. Int J Audiol 2016;55(11):605–15. https://doi.org/10.1080/14992027.2016.1198966.
[17] Muthuswamy R, Okada NJ, Jenkins FJ, McGuire K, McAuliffe PF, Zeh HJ, et al. Epinephrine promotes COX-2-dependent immune suppression in myeloid cells and cancer tissues. Brain Behav Immun 2017;62:78–86. https://doi.org/10.1016/j.bbi.2017.02.008.
[18] Stalder T, Steudte-Schmiedgen S, Alexander N, Klucken T, Vater A, Wichmann S, et al. Stress-related and basic determinants of hair cortisol in humans: a meta-analysis. Psychoneuroendocrinology 2017;77:261–74. https://doi.org/10.1016/j.psyneuen.2016.12.017.
[19] Marvar PJ, Harrison DG. Stress-dependent hypertension and the role of T lymphocytes. Exp Physiol 2012;97(11):1161–7. https://doi.org/10.1113/expphysiol.2011.061507.
[20] von Spee-Mayer C, Siegert E, Abdirama D, Rose A, Klaus A, Alexander T, et al. Low-dose interleukin-2 selectively corrects regulatory T cell defects in patients with systemic lupus erythematosus. Ann Rheum Dis 2016;75(7):1407–15. https://doi.org/10.1136/annrheumdis-2015-207776.