Case Report Article

The Cure of a Gaze-evoked Tinnitus by Repetition of Gaze Movements

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SUMMARY

Introduction: Gaze-evoked tinnitus (GET) is a phenomenon defined as tinnitus occurring with, or modulated by, horizontal and or vertical eye deviation from a neutral head position. Although it is usually described as sequelae of posterior fossa surgery, there are also reports of GET with no surgical history. It results from anomalous cross-modal interaction among sensorial systems and has no treatment approaches described up to now.

Objective: To describe the treatment that led to the cure of GET through the repetition of gaze movements.

Case Report: A 39-year-old female developed tinnitus in the left ear when she gazed at left or upwards, and in the right ear when she gazed at right and downwards. She underwent a program of exercises with the repetition of her own movements that evoked her tinnitus, as an attempt to accustom the response triggered by the gaze. The progressive improvement started after 2 weeks and the cure was achieved after 12 weeks of treatment.

Conclusion: The gaze-evoked tinnitus was cured by the repetition of movements that evoked such modulation. Therefore, neural plasticity may be implied both in the generation as well as in the treatment of such phenomenon.

Key words: tinnitus, eye movements, training, rehabilitation.

Introduction

Tinnitus is classically defined as an indiscernible hearing perception, with no concomitant external hearing stimulus. It is usually associated with hearing loss and, therefore, it can be part of the group different diseases (1).

In 1982, a different type of tinnitus was described by Whitaker in patient submitted to section of the 8th cranial pair to remove tumor. This patient developed tinnitus in only one gaze movement, that was called gaze-evoked tinnitus (GET) (2) and defined as a type of tinnitus which occurs or is modulated by eye movement in the horizontal and/or vertical axis with a neutral head position. In a unspoiled way, eye movement can activate or not tinnitus (3). Typically, GET occurs after deafferentation of the hearing path (lesion or surgery on cochlear nerve) (4), but it was already found in patients with no surgery history (5). Still in 1982, House reported the same type of tinnitus in five patients (6).

GET might be associated to integrated disorders among hearing, vestibular, visual and somatosensory ways, though its physiopathology is not yet established. The studies published up to now just describe new cases of GET, with no comments on a possible way of therapy. Although it was a target of study, Herraiz was the only to mention the use of tinnitus retraining therapy (lead by binaural sound generators) in one of his patients (7).

The target of this study is to describe the therapy which cured GET been based on principles of plasticity of the central nervous system.

Case Report

V.B.A., a 39-year-old caucasian woman, sought the *Grupo de Pesquisa em Zumbido da Divisão de Clínica Otorrinolaringológica do Hospital das Clínicas da FMUSP* (Team of Research in Tinnitus of the ENT Division at the Clinical Hospital – *FMUSP*) complaining of bilateral progressive gaze-evoked tinnitus 4 years ago, around one month later having undergone cochlear implant to the right.

Tinnitus occurred on the left ear when patient gazed to left or upwards, and on the right ear when she gazed to right or downwards. Therefore, tinnitus did not occur when there was neutral-eye position, even with head movement or when cochlear implant was temporally innefective. Patient reported a great negative effect on her quality of life, and highly interference on her emotional balance. She denied any worsening or improvement of such condition or the presence of other symptoms such as cervicalgy, temporomandibular disorders or bad eating habits related to tinnitus (caffeine, long fasting, swallowing or sweet compulsion).

As personal background, she presented an important surgery history which involved partial removal of vestibular schwannosis to the left in September, cochlear implant to the right in March (she was already deaf of right ear since her adolescence), two years later, she had total removal of vestibular schwannosis to the left in September, besides surgical correction of liquoric fistula in October.

The ENT exam was in normal condition. As part of a medical and audiological record, the following was required:

1. basic audiological evaluation, which presented profound bilateral sensorineural hearing loss in the right ear, which she had had since adolescence and, in the left ear after total removal of vestibular schwannosis).
2. laboratory exams (complete bloody count, fasting glycemia, fraction and total cholesterol, triglycerides, T_4 and TSH), all in normal condition.

Patient had already her magnetic resonance imaging and computed tomography scan of vestibular schwannosis removal to the left and the implant to the right done.

Plastic capacity of the nervous system was used due to the singularity of the case how it affected the patient's life, persisting in the repetition of the maneuvers which caused tinnitus in order to accustom the evoked response by gaze movement. Thus, the patient was asked to make repetition exercises of gaze movement in vertical direction (up and downwards) and horizontal one (right and left) twice a day. Each movement should be repeated 10 times in each direction starting from and ending in central position, remaining for 1 second in each direction.

After 14 days, patient reported the cure of tinnitus when gazing downwards and 90% reduction when gazing upwards, but remaining when gazing in lateral direction. She was asked to keep exercising for more 21 days. After that, she did not report any improvement. So, it was decided to increase the number of repetition up to 20 times each direction.

After 14 days, she reported a light improvement when gazing in horizontal position. She had suspended vertical-gazing exercises because the results were the same when gazing downwards and 90% improvement for

upwards gazing, and she was not disturbed by the vertical phenomenon any longer. Later, patient was asked to keep the same 20 time-repetition exercise in all directions which still inflamed tinnitus, though this time she should remain 5 seconds in each position.

After 28 days, patient reported tinnitus when gazing upwards, 40% improvement when gazing to the right and 80% improvement to the left.

It was decided to increase the number of remaining time for 30 seconds in each horizontal position. After 21 days, she was totally cured. The whole process lasted 12 weeks and patient suspended exercises after being cured and has not reported any recurrence up to now, two months later.

Discussion

Tinnitus caused by GET (gaze-evoked tinnitus) occurs due to cochlear nerve destruction, and it can start days or months after surgery. Although it is not a common disease, Biggs and Ramsden report a prevalence of 32% of the patients who have been operated through the labyrinth in order to have a resection of vestibular schwannosis, after the first year (3), which strikes more interest in it by the ENT doctors. In order to better describe GET, Lockwood and cols studied 17 patients suffering from such tinnitus, but with no surgery history on the posterior fossa, showing the complexity of the mechanisms which cause tinnitus (5).

GET is similar to other types of tinnitus modulated by somatosensorial system, such as evoked tinnitus through ipsilateral hand and the modulate tinnitus through facial or jaw movement (3). In our case, GET appeared one month after cochlear implant on the right ear and it came out when implant was on. Although such ear was already affected by profound hearing loss as said in other studies, GET only came out at electrical stimulation of the hearing path by the cochlear implant. Although this process cannot be precisely defined, electrical stimulation from cochlear implant was activating connections between hearing and visual ways. Due to the fact that there are no other cases described after electrode implant up to now, it is not possible to compare data.

Many theories try to explain the origin of GET. There are suppositions on the existence of a neural integrator responsible for abnormal interaction between dorsal cochlear nucleus and cerebellopontine areas responsible for saccadic eye movements (4). There is also the theory of para-abducent nucleus rise over dorsal cochlear nucleus, which causes the same symptoms (2).

Levine supports that such tinnitus is caused by a disinhibition of the dorsal cochlear nucleus, which would increase its electrical activity. This is caused by deafferentation of the impulse, which is common on hearing losses resulted from surgeries for removing vestibular schwanoma. Besides, tinnitus modulation by somatic system would occur by an association of the somatosensorial medular nucleus with dorsal cochlear nucleus, evoking another source of disinhibition which would cause symptoms.

Yet, Levine (as the origin of tinnitus is associated to a reduction of the nervous impulse and disinhibition of the dorsal cochlear nucleus) reported 80% improvement of tinnitus in patients with profound hearing loss after cochlear implant surgery, taking into account that a reestablishment of the electric impulse on the pre-implant tinnitus occurs after the surgery. Therefore, our patient developed GET only after cochlear implant surgery, which suggests the presence of other mechanisms involved in the origin of the symptom or an excitatory effect of the implant over dorsal cochlear nucleus.

Under this context, the theory of neuronal plasticity with the possibility of deviated interactions in the whole multisensorial system is increasing (7). According to those, the lack of peripheral information causes changes on cortical maps and a reorganization of the primary and secondary cortex. This cortical transformation is accomplished with reduction of the areas with no stimulation and an expansion of adjoining areas. Thus, hearing deafferentation can cause positive neuroplastic effects such as adaptation and compensation, and also it can cause negative effects with pathological changes and undesirable clinical signs such as GET (7).

GET is still not well defined, though few studies up to now have talked about a possible therapy. Herraiz made use of an tinnitus retraining therapy (led with binaural sound generators) on a patient with a relative improvement though did not detail the case (7). It has also been mentioned some attempts, but no success, involving transcutaneous, promontory and endocochlear ok electrical stimulation (7,8), as well as the use of medicine (7).

This is the first report in which the retraining way is used through repetitive stimuli for GET therapy, based on neuroplasticity principles. Similar principles are used on vestibular rehabilitation (VR) therapy for body unbalance, developed by Cawthorn and Cooksey in 1940 (9). The main core of VR is the repetition of a series of exercises which raise the compensation of the CNS through eye, cervical and body movements (10). According to most of the published studies, the exercises have been successfully used on patients with vestibular problems (11,13).

In this current case report, it was traced a parallel view between VR with the method used to cure GET, which the retraining of this type of tinnitus would occur by repeating its own deflagrating movements, providing an adaptation of the hearing system and the cure of the symptom, which was confirmed with therapy.

The studies of Lockwood (14) showed a central reorganization involved in the origin of GET. Theoretically, the repetition of movements suggested in this study could instigate a new compensatory central response through neuronal plasticity, allowing a reorganization of cortical areas.

It was interesting to notice that the vertical component of GET responded quicker to therapy than the horizontal component did. Besides, the vertical component responded better to the increase of repetition of the eye movement, while the horizontal component did better to the duration of each movement. Those data show the variety of neural processes involved on this phenomenon and still need to be clear.

Thus, it is believed that this report shows new perspectives for tinnitus therapy related to visual modulation phenomenon, which might be expanded to tinnitus modulation by other sensorial systems.

Final Notes

Gaze-evoked tinnitus was cured by the repetition of movements that caused such modulation. Therefore, the plastic capacity of the central nervous system can justify both its appearing and therapy.

References

1. Jastreboff PJ, Jastreboff MM. Tinnitus retraining therapy for patients with tinnitus and decreased sound tolerance. Otolaryngol Clin N Am. 2003, 36:321-44.

2. Whittaker CK. Letter to the editor. Am J Otol. 1982, 4:188.

3. Biggs NDW, Ramsden RT. Gaze-evoked tinnitus following acoustic neuroma resection: a de-afferentation plasticity phenomenon? Clin Otolaringol. 2002, 27:338-43.

4. Wall M, Rosemberg M, Richardson D. Gaze-evoked tinnitus. Neurology. 1987, 37:1034-36.

5. Coad ML, Lockwood A, Salvi R, Burkard R. Characteristics of patients with gaze- evoked tinnitus. Otology & Neurotology. 2001, 22:650-54.

6. House WF. Letter to the editor. Am J Otol. 1982, 4:188.

7. Herráiz C, Hernández-Calvín FJ, Plaza G, Toledano A, Santos G. Interacción multisensorial en el acúfeno: evocación por movimientos oculares y estimulación somatosensorial. Acta Otorrinolaringol Esp. 2003, 54:329-36.

8. Levine RA. Somatic tinnitus and the dorsal cochlear nucleus hypothesis. Am J Otolaryngol. 1999, 20(6):351-62.

9. Bittar RSM, Pedalini MEB, Formigoni LG. Reabilitação Vestibular: Uma arma poderosa no auxílio a pacientes portadores de tontura. Rev Bras Otorrinolaringol. 1999, 65:266-69.

10. Johansson M, Akerlund D, Larsen HC, Andersson G. Randomized controlled trial of vestibular rehabilitation combined with cognitive-behavioral therapy for dizziness in older people. Otolaryngol Head Neck Surg. 2001, 125:151-56.

11. Cowand JL, Wrisley DM, Walker M, Strasnick B, Jacobson JT. Efficacy of vestibular rehabilitation. Otolaryngol Head Neck Surg. 1998, 118:49-54.

12. Bittar RSM, Pedalini MEB, Medeiros IRT, Bottino MA, Bento RF. Reabilitação vestibular na criança: estudo preliminar. Rev Bras Otorrinolaringol. 2002, 68(4):496-99.

13. El-Kashlan HK, Telian AS. Diagnosis and initiating treatment for peripheral system disorders: imbalance and dizziness with normal hearing. Otolaryngol Clin North Am. 2000, 33(3):563-78.

14. Lockwood AH, Wack DS, Burkard RF, Coad BA, Reyes SA, Arnold SA, Salvi RJ. The functional anatomy of gaze-evoked tinnitus and sustained lateral gaze. Neurology. 2001, 56:472-80.

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