

HYPERBARIC OXYGEN THERAPY IN THE TREATMENT OF TINNITUS AND HEARING DISORDERS IN MUSICIANS

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Abstract

Musicians are inherently considered a risk group for the development of tinnitus and hearing disorders. Contemporary renowned performers suffer from tinnitus and hearing difficulties mainly due to increased acoustic load. However, from the history as well as from the present, we know the specific examples of musicians suffering from disorders or even hearing loss in whom etiopathogenesis of the disease is much more complex. Hyperbaric oxygen therapy with its complex effect on the metabolism of an individual appears to be auspicious and promising therapeutic tool for individuals with acquired hearing impairment. In the case of its using it is necessary to develop and validate therapeutic approaches from a comprehensive view of physicians, nurses as well as from the perspective of laboratory determination of important metabolic markers.

Key words: Tinnitus, Hyperbaric oxygen therapy, A musician.

Introduction

Tinnitus is the most frequent symptom connected with the damage of inner ear. Clinically it is displayed by ringing in the ears, but also can sound like roaring, clicking, hissing, or bussing. It may be soft or loud, high pitched or low pitched, in either one or both ears. Its character might be subjective or objective. However, it is considered a pathological symptom when the patient can hear these sounds for longer than 10 minutes during majority days of a week. It is often epiphenomenon during specific diseases, acoustic trauma, after the use of ototoxic medicaments or other ototoxic substances, such as nicotine. Nicotine belongs to the most toxic alkaloids that decrease the flow of blood through vasospasm of blood vessels. Tinnitus is often demonstrated as viral inflammation of inner ear for unknown reason. It can be classified acute or chronic, if its duration does not go beyond one year. It is often found in people with hearing disorder and also in healthy ones. Its treatment is mainly symptomatic, by which we try to relieve tinnitus and its impact on quality of patient's life [1-7].

Tinnitus develops as the result of various causes, including stress, allergies, and infections. Especially in musicians the frequent, prolonged exposure to the loud volume of concerts and crowds puts musicians at prime risk of hearing improvements, including tinnitus and noise-induced hearing loss. They usually develop tinnitus as the result of playing with loud bands and thus the most common cause is exposure to loud music.

Famous Musicians Suffering from Tinnitus

Huxtable, R. [8] documents that Ludwig van Beethoven was born into a musical family in Bonn, Germany, in December 1770. The author says that Beethoven had exceptionally keen hearing in early life. A loss of ability to hear high-pitched sounds, an indication of nerve deafness, first became apparent at the age of twenty-seven. By this age, he had written his *First Symphony*, the first two piano concertos, the piano trios of Opus 1 and Opus 11, the piano sonatas of Opus 13, the cello sonatas of Opus 5, and most of the work on the string quartets of Opus 18. He did not admit to his deafness for another three years.

The writings of McCabe [9] and Huxtable, R. [8] indicate that Beethoven had tinnitus, reduced word recognition and, by his own words, reduced sensitivity to high frequency sounds. His deafness began in 1798 and Beethoven had lost 60 % of his hearing by 1801 at the age of 31. At 46 in 1816 he was completely deaf.

Although Huxtable, R. [8] indicates that Beethoven's hearing impairment began slowly at age 27, by age 31 composer was having difficulty in conversation and other situations where this sense was important. At the Ludwig van Beethoven's biographic site [10], there are found letters that well document Beethoven's frustration with the continuous loss of hearing (fig. 1). Here are a few examples he wrote in his letter to his friend and a doctor Franz Gerhard Wegeler from Bonn who moved to Vienna and married Eleanore von Breuning. The letters are dated June 29th, 1801:

- “(...) How sad is my lot, I must avoid all things that are dear to me.”
- “(...) Oh, how happy I should be if my hearing were completely restored, then I would hurry to you (...)”
- “(...) For two years I have avoided almost all social gatherings because it is impossible for me to say to people that I am deaf. If I belonged to any other profession it would be easier, but in my profession it is a frightful state.”
- “(...) Of course, I am resolved to rise above every obstacle, but how will it be possible? (...)”



Figure 1 The extract from the letter of Beethoven to his friend Karl Amenda, Dated July, 1st, 1801 (L. van Beethoven's biographic site, 2011)

Awesome Stories [11, 12] indicates that to cope with his growing deafness, Beethoven began writing symphonies. At high speed, he worked on several projects at once and he lived entirely in his music. He made several attempts to be cured of his deafness, which was devastating for him as to a composer and a musician.

Hicks, M. [13] summarises his attempts to be cured by showing one of his letters to an old friend: *"The cause of this must be the condition of my belly which as you know has always been wretched and has been getting worse, since I am always troubled with diarrhoea, which causes extraordinary weakness. Frank wanted to tone up my bod by tonic medicines and restore my hearing with almond oil, but nothing happened, my hearing grew worse and worse, my bowels remained as they had been. This lasted until the autumn of the last year and (...) then came a medical ass who advised me to take cold baths for my health. A more sensible one advised the usual lukewarm Danube bath. That worked wonders, my belly improved, but my deafness remained and became even worse (...)."*

Even nowadays there were raised many questions to the cause of Beethoven's deafness. Huxtable, R. [8] sums the medical evidence up suggesting that the cause of his deafness is essentially unknown as is the case with many instances of deafness today. Whatever the pathophysiology of composer's hearing loss, he would have been an extremely challenging patient. Tinnitus can be treated today, however, as he was a very successful musician, no matter how perfect the treatment programme he would obtain, he would never be satisfied as he always wanted to reach something more beautiful and perfect.

There are several contemporary famous musicians who have developed tinnitus as a result of playing with loud bands, such as Metallica drummer Lars Ulrich, the Who's Pete Townshend, Nine Inch Nails' Trent Reznor and also Eric Clapton. Bob Dylan developed tinnitus after years of playing loud, live music. Ozzy Osbourne described his tinnitus in Sunday Times of London as constant ringing in his ears, which has also made him somewhat deaf. Phil Collins believes that years behind a loud drum kit have caused him to develop tinnitus. Barbra Streisand has suffered from tinnitus since she was a child. Anthony Kiedis developed tinnitus after the years of performing with the Red Hot Chili Peppers. Moby developed tinnitus after playing with loud punk bands in his early career. He has said that since then, he always wears some form of hearing protection. And final, the Who's guitarist Pete Townshend has even become the poster boy for tinnitus. He described his health condition in several interviews as severe hearing damage which is manifested as ringing in the ears at frequencies that he plays guitar which hurts, is painful and frustrating [14, 15].

Epidemiology

Tinnitus is also referred to as rustle in the ear and it frequently occurs in the connection with shortage of hearing. It is considered epiphenomenon of hard-of-hearing. Tinnitus is commonly accompanied by hearing loss, and roughly 90% of persons with chronic tinnitus have some form of hearing loss [16, 4]. On the other hand, only

in about 30-40% of persons with hearing loss is tinnitus being developed. According to Park, R. J. and Moon, M. D. [17], hearing impairment roughly doubles the odds of having tinnitus, and triples the odds of having annoying tinnitus. Less commonly, tinnitus may be accompanied by hyperacusis, an abnormal sensitivity to sound.

Adjajian, P. et al. [1] indicate that about 10 to 15% of the entire population has some type of constant tinnitus, and about 20 % of them seek medical attention. Similar statistics are found in England [19] and in Korea [18].

Tinnitus, the phantom perception of sound, is physiologically characterized by an increase in spontaneous neural activity in the central auditory system. However, as tinnitus is often associated with hearing impairment, it is unclear how a decrease of afferent drive can result in central hyperactivity [7]. Associative risks for tinnitus include intense noise exposure, ototoxic insults, head and neck injuries, and age-related hearing impairment [7, 5]. Peripheral trauma causes partial deafferentation of the auditory nerve fibers, which reduces afferent drive to its central target, the cochlear nucleus. However, in experimental animal models, noise-trauma paradoxically induces elevated spontaneous activity in ventral and dorsal cochlear nuclei [7].

Tinnitus is more common with advancing age. In a large study of more than 2000 adults aged 50 and above, 30.3% Sindhusake, D., et al. [6] reported having experienced tinnitus, with 48% reporting symptoms in both ears. Tinnitus had been present for at least 6 years in 50% of cases, and most (55%) reported a gradual onset. Tinnitus was described as mildly to extremely annoying by 67% [6].

Hyperbaric Oxygen Therapy as a new modality of treatment of tinnitus

Hyperbaric oxygen therapy (HBOT) is a therapeutic approach where the patient is exposed to 100% oxygen at pressures higher than ambient (1 ATA). This leads to an increased blood oxygen level, which than can penetrate to ischemic areas more deeply than under normobaric conditions [20]. Normally 97% of the oxygen transported from the lungs to the tissues is carried in chemical combination with hemoglobin or red blood cells, and the remaining 3% in a dissolved state in plasma. Under hyperbaric conditions, it is possible to dissolve sufficient oxygen, i.e., 6 vol. % in plasma, to meet the usual requirements of the body. In this case oxyhemoglobin will pass unchanged from the arterial to the venous side because the oxygen physically dissolved in solution will be utilized more readily than that bound to hemoglobin [21].

HBOT is a standard therapy for decompression sickness, gas embolism and CO poisoning. HBOT is also effective for gas gangrene, anaerobic infection, diabetic foot, Burger's disease and other oxygen-deficient conditions. In addition, HBOT has been proved effective in the healing of chronic wound, such as radiation-induced soft tissue necrosis. Meanwhile, many studies reported the therapeutic or preventive effect of HBOT in various kinds of inflammatory or immune-mediated diseases, such as systemic lupus erythematosus, atherosclerosis, collagen-induced arthritis, Crohn's disease, ulcerative colitis and atopic dermatitis, although these diseases are not included in the current indication of HBOT [3, 21].

Although there is large body evidence that HBOT is useful as a therapy, there is also data indicating that the use of hyperbaric oxygen can have serious side effects. The main concern in HBOT is oxidative stress and/or oxygen toxicity that can affect multiple organs [20]. The severity of oxygen poisoning increases progressively with increase of the inspired partial pressure of oxygen and with greater duration of exposure [22].

Porubsky, C. et al. [23] analysed the effectiveness of HBOT in the context of accompanying factors. They randomized 360 patients suffering from tinnitus into 2 HBOT treatment protocols (group A: 2.2 bar for 60 min bottom time and group B: 2.5 bar for 60 min bottom time once a day for 15 days). All patients were asked to fill in a questionnaire (social and medical history, tinnitus characteristics, pre- hyperbaric oxygen therapy duration of tinnitus, prior therapy, pre-treatment expectation, accompanying symptoms). A subjective assessment of the therapeutic effect was obtained. Twelve patients (3.3%) experienced complete remission of tinnitus, in 122 (33.9%) the intensity lessened, and 44 (12.2%) had a subjectively agreeable change of noise characteristics. No change was found in 157 cases (43.6%) and 25 (6.9%) experienced deterioration. There was no statistically significant difference between groups A and B ($p > 0.05$). Out of 68 patients with a positive expectation of hyperbaric oxygen therapy effects, 60.3% stated that the tinnitus had improved whereas only 47.2 and 19%, respectively, out of patients who underwent therapy with an indifferent ($n = 271$) or negative expectation ($n = 21$) reported an improvement. The influence of subjective expectation on the outcome was statistically significant ($p < 0.05$). Based on their results, the therapeutic effects of hyperbaric oxygen therapy on subjective tinnitus may be substantially influenced by psychological mechanisms.

In our preliminar study [2], we verified the effect of HBOT on quality of life (QoL) of probants with tinnitus. Patients were exposed to 100% oxygen at the pressure 2ATA. The duration of one exposure was 90 minutes, the number of exposures prescribed by the doctor was 10. Data were collected by questionnaires prior the first exposure in a hyperbaric chamber, after the last exposure and then within an interval of three months after the end of HBOT. For the pilot study were statistically evaluated data of 10 subjects who were chosen from a total of 30 probants therapeutically exposed to 10 exposures of HBOT. In these 10 individuals there were available data for 3 months interval after treatment with HBOT. The preliminary testing results of probants show that the subjective perception of quality of life after passing HBOT is statistically significantly higher compared with the situation before therapy ($n=10$, $p=0.01$, analysis of variance) and within an interval of three months it does not changes

significantly ($p > 0.05$, Tukey-Kramer test). The own perception of the impact of tinnitus on quality of life and ability to work of subjects is not significant ($p > 0.05$, Tukey-Kramer test).

Conclusions

Tinnitus is an accompanying phenomenon with certain diseases, but in the vast majority of cases its origin and cause is unknown. Treatment of tinnitus is mostly symptomatic. In these cases, auxiliary treatment is used, which, although it does not remove the cause of the troubles, but reduce the symptoms. The goal of the study was to extend the knowledge about tinnitus especially in the group of musicians and to presented the potency of hyperbaric oxygen therapy in this treatment.

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