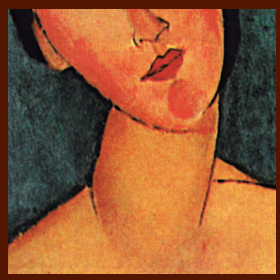
OTORHINOLARYNGOLOGY

PUBBLICAZIONE PERIODICA TRIMESTRALE - POSTE ITALIANE S.P.A. - SPED. IN A. P. D.L. 353/2003 (CONV. IN L. 27/02/2004 N° 46) ART. 1, COMMA 1, DCB/CN - ISSN 2724-6302 TAXE PERÇUE



QUARTERLY JOURNAL ON
OTORHINOLARYNGOLOGY,
AUDIOLOGY
PHONATRICS, HEAD AND
NECK SURGERY
MAXILLO-FACIAL SURGERY
PLASTIC RECONSTRUCTIVE
SURGERY
OTONEUROSURGERY

VOL.73 No.3
SEPTEMBER 2023

EDIZIONI MINERVA MEDICA

Online version at https://www.minervamedica.it

Otorhinolaryngology 2023 September;73(3):156-9
DOI: 10.23736/S2724-6302.23.02502-1

SPECIAL ARTICLE

TINNITUS

Therapy for the treatment of tinnitus

Massimo CAVACECE *

Department of Mechanical and Civil Engineering, University of Cassino and South Lazio, Cassino, Frosinone, Italy

*Corresponding author: Massimo Cavacece, Department of Mechanical and Civil Engineering, University of Cassino and South Lazio, Cassino (FR), Italy. E-mail: cavacece@unicas.it

ABSTRACT

The research proposes a therapeutic solution to the auditory disorder called tinnitus by generating noise associated with an electromedical device. Tinnitus is a common but poorly understood disorder that has a strong association with aging. Although tinnitus is often associated with hearing loss, in many cases the origin may be central. Multiple treatment options may help in the management of this chronic condition. The role of the cochlea in tinnitus is considered, and in particular the concept of discordant damage between inner and outer hair cells is described.

(*Cite this article as:* Cavacece M. Therapy for the treatment of tinnitus. Otorhinolaryngology 2023;73:156-9. DOI: 10.23736/S2724-6302.23.02502-1)

KEY WORDS: Tinnitus; Audiology; Therapeutics.

The auditory disorder called tinnitus consists of annoying noises to the human ear with an influence on the quality of life of the person.[1-3]

Electromedical devices may have the following technologies.

An electric current model uses quantum molecular resonance (QMR) with an alternating electrical signal emission in the frequency range from 4 to 16 MHz. The field 4 to 16 MHz characterizes the molecular bonds of the biological tissue.[4-6] The signal has anti-inflammatory and regenerative properties with targeted action on the disorder. QMR technology operates at temperatures below 50 °C.[6-8] QMR interacts with biological tissue without heat production. QMR avoids cell death and thermal damage. The heat generated is negligible. QMR works on soft tissues without damaging them, ensuring better tissue scarring, decreased inflammation of the treated area, and reduced pain. Recovery times can be short. The meaning of resonance indicates that the energy provided by QMR breaks the molecular bonds with a negligible temperature increase. The term quantum means the discrete content of the power.[9, 10] Device calibration with QMR technology provides the exact amount of energy. Suppose the energy value of the quantum is equal to that of the bonds of the molecule concerned.[11-13] In that case, the energy content can break the bonds without increasing the kinetic and thermal energy that can damage cells. Conversely, if the energy value of how much is different from that of the bonds of the affected molecule, the energy content increases the kinetic energy and thermal energy of the molecule without breaking the bonds of the cells.[14-16]

Physiotherapy and aesthetic medicine can use molecular quantum resonance with adequate intensity and frequencies to induce tissue regeneration by stimulating adult stem cells.[17-19]

The second type of electromedical device generates an inductive signal to stimulate damaged cells. Such electromedical acts through electromagnetic fields with high-intensity pulsed type with beneficial effects on the tissues of the human body. The system of high-intensity electromagnetic fields can generate the depolarization of the cells of the neuromuscular tissue.[20-22] Each cell has, in fact, a potential membrane value at physiological rest due to differences in electrical charges. If this changes,

the action of the magnetic fields can restore normal equilibrium.[23-25]

The third type of electromedical can implement sound therapy using an acoustic signal. The sound, perceived through the eardrum's movement, is transmitted by the chain of ossicles (hammer, anvil, and bracket) transmitting the sound wave inside the cochlea.[26-28] This percussion generates activity in the perilymph and, therefore, an oscillation of the lashes concerning the immobile victory membrane. Fluid displacements and, thus, the fluctuation of eyelashes lead to changes in membrane potential.[29-31] The brain perceives these changes as a change in frequency. Comparison of information with visual or somatosensitive signals detects the position of the head.[32-35] The human hearing range varies from 20 Hz to 20 kHz. The basilar membrane also generates passive tuning, a rough discrimination of frequencies optimized by the acoustic cells through active tuning.[36-38]

An essential membrane on which the Organ of Courts rests characterizes passive tuning. The geometric and mechanical characteristics vary from the base to the apex of the snail, generating different vibrations and, therefore, the ability to pick up different frequencies. Active tuning presents differences in the molecular composition of sensitive membranes and the shape and length of stereocilia.[39-42] Longer eyelashes are exposed to low frequencies, while shorter eyelashes are sensitive to high frequencies.

The trouble

Tinnitus, or tinnitus, is an auditory disorder consisting of noises such as whistling, humming, and rustling, which the ear perceives as annoying, affecting the concerned subject's quality of life. Objective tinnitus accounts for 5% of cases of tinnitus, associated with a physical noise on the person's ear that the stethoscope can evaluate. Pathologies of the circulatory system or anatomical structures near the inner ear cause objective tinnitus. The pulsation of a vessel in the middle ear causes tinnitus or a periodic pressure variation and, therefore, an audible sound. Conversely, subjective tinnitus is a prevalent type not associated with a physical noise perceived only by the patient. Scientific studies have shown that it is attributable to noise trauma, side effects of specific drugs, and periods of severe anxiety and stress. In general, tinnitus is a damage of the inner ear. The brain processes sensory perceptions, which cannot directly perceive sounds, lights, or other stimuli in their original form. Still, it receives bioelectric signals derived from the conversion made by specific receptors, such as the ciliate cells of the inner ear (in the cochlea). These cells have thin eyelashes that vibrate in response to different sound frequencies. Traumas or pathologies damage these cells. The subject may also lose hearing. If the original cause removes the tinnitus, the discomfort may persist because the brain stores the sound and can regenerate it. In the case of tinnitus, the upper nerve centers can generate it even if the starting cause has been removed.

Psychoacoustic measurements

Acuphenometry has the following measurements.

Pitch matching tinnitus (PMT) identifies the frequency, or the band of frequencies occupied by tinnitus, that has defined frequency characteristics. The examination sends the patient a sound test with an intensity of about 10 dB H.L. above the auditory threshold. The procedure involves two stages: determining the frequency in the contralateral ear and testing in the ipsilateral ear. The forced choice between two alternatives or A/B tests is used.

Relative loudness of the tinnitus (RLT) locates the relative height for the patient's perception of tinnitus. The ascending method involves sending a tone whose frequency has been identified with the PMT in the contralateral ear to that in which tinnitus is present, first looking for the threshold and then increasing by 5 dB H.L. until reaching the height of the tinnitus. Having identified a range of similarities, the 1 dB H.L. step performs the correct identification.

Masking of the tinnitus (MT) identifies the masking threshold of the tinnitus itself. Assumed a different tone from tinnitus, often white or pink noise with predominant frequencies (the same as found in PMT), the style in the affected ear is sent with a step of 1 dB H.L. above the threshold until the so-called minimum level of masking or sound intensity at which that given sound completely covers the tinnitus.

Residual inhibitor (RI) evaluates residual inhibition of tinnitus following a masking period. The test offers the patient a masking tone at the minimum level of masking detected, increasing by 10 dB H.L. for sixty seconds. Ultimately, the patient describes the tinnitus that he perceives and its possible modifications. If the tinnitus disappears completely, it is a matter of complete or positive residual inhibition (IRC). In contrast, if it is partially reduced without fading, it is a partial or somewhat positive residual inhibition (IRP).

Tinnitus retraining therapy

Tinnitus maskers generate a series of noises to mask tinnitus discomfort and deceive the brain by accustoming it to the sound itself. The increase in external noise hinders the perception of internal sounds, helping the brain to focus on external ones. Increasing the ambient noise level by reproducing white noise in the ear reduces the apparent tinnitus volume. The nearby noise level is greater than the perceived volume of tinnitus. The intensity of noise can entirely or partially mask tinnitus. Tinnitus retraining therapy (TRT) programs the brain to reduce the perception of the disorder. The patient perceives his tinnitus in frequency and intensity. Tinnitus cannot be measured by diagnostic tests, being a subjective phenomenon. The therapy reproduces the exact sound during the session to deceive the brain. The patient gets used to the presence of tinnitus, which becomes a neutral sound that is no longer annoying. The specialist may carry out objective examinations, such as hearing or MRI examinations. The TRT provides sound enrichment to the patient. The adaptation process takes three to nine months. Tinnitus can become progressively less annoying until it becomes negligible daily background noise.

As previously mentioned, the therapy deceives the brain by reproducing the same buzz perceived by the patient, increasing the intensity compared to the signal intensity caused by tinnitus. The ringing of tinnitus consists of the malfunctioning of an area of hair cells in the ear, which causes a persistent sound spread over all frequencies of the audible. A white noise, added to a pure tone, represents the signal reproduced during the treatment. A refined style is a sound at a single frequency, a sine wave at a pre-set frequency in the range of the audibility field. By identifying the frequency and intensity of tinnitus through doctor-patient feedback, the device can customize the treatment for each individual by setting frequency and intensity. The treatment involves the combination of white noise and pure tone. White noise has a constant amplitude over the entire frequency spectrum. White noise comprises all frequencies with a similar intensity for each. White noise masks other sounds and exceeds background noise in indoor environments. Likewise, it plays a crucial role in treating tinnitus as it helps the brain ignore sounds at a precise frequency and intensity.

TRT is a sound therapy. The term sound therapy, however, is incorrect and misleads, suggesting that tinnitus can disappear simply by listening to white noises, nature noises, rustling, and lapping waves. The TRT provides personalized sound stimulation through wearable generators and a counseling path with a psychotherapist. It consists of sound stimulation through tiny and discreet hearing aids. The devices deliver a white noise adapted to the patient's needs and calibrated according to the intensity of tinnitus (previously measured by acuphenometry. The presidium can be worn throughout the day and maintained even during sleep. The sound stimulation and a counseling path with a psychotherapist manage the emotional qualities related to the presence of tinnitus. This combination is fundamental for the success of the therapy. It exploits neuroplasticity and thus readjusts the individual to consider tinnitus a neutral sound.

As for the sound enrichment, the chosen signal presents at a level of intensity defined as mixing-pointal. The patient can hear the intervention of the excellent generator and his own tinnitus. The aim is to act on the autonomous nerve centers (limbic and neuro vegetative systems) to reduce their tinnitus. The demystification of tinnitus occurs through targeted counseling interventions that determine the assumption of cognitive behavioral attitudes aimed at establishing defense mechanisms before the symptom of tinnitus. Questionnaires and tests monitor the evolution of the tinnitus-patient relationship from conflict to family life.

Therapy times include five/six multidisciplinary sessions distributed over six months. The TRT needs the following professional figures: ear specialist, audio prosthetist, or counselor, and presupposes an always binaural application, even in cases of monolateral tinnitus.

References

1. Ahmad N, Seidman M. Tinnitus in the older adult: epidemiology, pathophysiology and treatment options. Drugs Aging 2004;21:297–305.

2. Aksoy S, Firat Y, Alpar R. The Tinnitus Handicap Inventory: a study of validity and reliability. Int Tinnitus J 2007;13:94–8.

3. Tunkel DE, Bauer CA, Sun GH, Rosenfeld RM, Chandrasekhar SS, Cunningham ER Jr, *et al*. Clinical practice guideline: tinnitus. Otolaryngol Head Neck Surg 2014;151(Suppl):S1–40.

4. Beck JS. Cognitive Therapy: Basics and Beyond. Second edition. New York: Guilford Press; 2011.

5. Biswas R, Lugo A, Akeroyd MA, Schlee W, Gallus S, Hall DA. Tinnitus prevalence in Europe: a multi-country cross-sectional population study. Lancet Reg Health Eur 2021;12:100250.

6. Cespuglio D, Maggio M, Maggio O, Martines F, Martines E. Acufeni: epidemiologia. Acta Pediatrica Mediterranea 2005;21:29–31.

7. Couth S, Mazlan N, Moore DR, Munro KJ, Dawes P. Hearing Difficulties and Tinnitus in Construction, Agricultural, Music, and Finance Industries: Contributions of Demographic, Health, and Lifestyle Factors. Trends Hear 2019;23:2331216519885571.

8. Dauman R, Tyler RS. Some considerations on the classification of tinnitus. In: Aran J-M, Dauman R, editors. Proceedings of the Fourth International Tinnitus Seminar. Amsterdam: Kugler; 1992. p. 225–9.

9. Feldmann H. Masking mechanisms: ipsilateral, contralateral masking. Proceedings of the second international tinnitus seminar. J Laryngol Otol Suppl 1984;9:54–8.

10. Feldmann H. Tinnitus masking curves: updates and review. proceedings of the second international tinnitus seminar. J Laryngol Otol Suppl 1984;9:157–60.

11. Goldstein B, Shulman A. Tinnitus classification: medical audiologic assessment. Tinnitus, proceedings of the first tinnitus seminar. J Laryngol Otol 1981;4:33–8.

12. Henry JA, Griest S, Zaugg TL, Thielman E, Kaelin C, Galvez G, *et al.* Tinnitus and hearing survey: a screening tool to differentiate bothersome tinnitus from hearing difficulties. Am J Audiol 2015;24:66–77.

13. Henry JA, Griest S, Zaugg TL, Thielman E, Kaelin C, Galvez G, *et al.* Tinnitus and hearing survey: a screening tool to differentiate bothersome tinnitus from hearing difficulties. Am J Audiol 2015;24:66–77.

14. Scherer RW, Formby C; Tinnitus Retraining Therapy Trial Research Group. Effect of Tinnitus retraining therapy vs standard of care on Tinnitus-related quality of life: a randomized clinical trial. JAMA Otolaryngol Head Neck Surg 2019;145:597–608.

15. Jastreboff PJ, Jastreboff MM, Sheldrake JB. Audiometrical characterization of hyperacusis patients before and during TRT. Proceedings of the Sixth International Tinnitus Seminar. London: JWP; 1999. p. 495-8.

16. Johnson RM. The masking of tinnitus. Tinnitus: treatment and relief. In: Vernon JA, editor. Tinnitus treatment and relief. Allyn and Bacon; 1998.

17. Langguth B, Elgoyhen AB, Cederroth CR. Therapeutic Approaches to the Treatment of Tinnitus. Annu Rev Pharmacol Toxicol 2019;59:291–313.

18. Manfredini D, Olivo M, Ferronato G, Marchese R, Martini A, Guarda-Nardini L. Prevalence of tinnitus in patients with different temporomandibular disorders symptoms. Int Tinnitus J 2015;19:47–51.

19. Meikle MB, Schuff N, Griest S. Intra-subject variability of tinnitus: observation from the Tinnitus Clinic. Feldman H, editor. Proceedings of the Third International Tinnitus Seminar. Karlsruhe: Harsh Verlag; 1987. p. 175-80.

20. Mineau SM, Schlauch RS. Threshold measurement for patients with tinnitus: pulsed or continous tones. Am J Audiol 1997;6:52–6.

21. Monzani D, Genovese E, Marrara A, Gherpelli C, Pingani L, Forghieri M, *et al.* Validity of the Italian adaptation of the Tinnitus Handicap Inventory; focus on quality of life and psychological distress in tinnitus-sufferers. Acta Otorhinolaryngol Ital 2008;28:126–34.

22. Mudry A. Otology in Medical Papyri in Ancient Egypt. Mediterr J Otol 2006;3:133–42.

23. Newman CW, Sandridge SA, Jacobson GP. Psychometric adequacy of the Tinnitus Handicap Inventory (THI) for evaluating treatment outcome. J Am Acad Audiol 1998;9:153–60.

24. Newman CW, Jacobson GP, Spitzer JB. Development of the Tinnitus handicap inventory. Arch Otolaryngol Head Neck Surg 1996;122:143–8.

25. Partyka M, Neff P, Bacri T, Michels J, Weisz N, Schlee W. Gender differentiates effects of acoustic stimulation in patients with tinnitus. Prog Brain Res 2021;263:25–57.

26. Penner MJ. Masking of tinnitus and central masking. J Speech Hear Res 1987;30:147–52.

27. Pilgramm M, Rychlick R, Lebisch H, Siedentop H, Goebel G, Kirchhoff D. Tinnitus in the federal Republic of Germany: a representative epidemiological study. ScienceOpen 1999.

28. Porika RK, Doraisami B, Ravichandran A. The efficacy of digital hearing aids in the management of Tinnitus in individuals with sensorineural hearing loss. Int Tinnitus J 2021;25:100–6.

29. Quaranta A, Assennato G, Ferri GM, Bellini V, Corrado V, Porro A. Quaranta A, Assennato G, Ferri GM, Bellini V, Corrado V, Porro A. Epidemiologia dei problemi uditivi nella popolazione adulta in Italia. Audiol Ital; 1991.

30. Ralli M, Balla MP, Greco A, Altissimi G, Ricci P, Turchetta R, *et al.* Work-related noise exposure in a cohort of patients with chronic tinnitus: analysis of demographic and audiologic characteristic. Int J Environ Res Public Health 2017;14:1035.

31. Rubak T, Kock S, Koefoed-Nielsen B, Lund SP, Bonde JP, Kolstad HA. The risk of tinnitus following occupational noise exposure in workers with hearing loss or normal hearing. Int J Audiol 2008;47:109–14.

32. Savastano M. Tinnitus with or without hearing loss: are its characteristics different? Eur Arch Otorhinolaryngol 2008;265:1295–300.

33. Searchfield GD, Kaur M, Martin WH. Hearing aids as an adjunct to counseling: tinnitus patients who choose amplification do better than those that don't. Int J Audiol 2010;49:574–9.

34. Shim HJ, Kim SK, Park CH, Lee SH, Yoon SW, Ki AR, *et al.* Hearing abilities at ultra-high frequency in patients with tinnitus. Clin Exp Otorhinolaryngol 2009;2:169–74.

35. Shulman A. External electrical stimulation in tinnitus control. Am J Otol 1985;6:110–5.

36. Skog C, Fjellner J, Ekberg E, Häggman-Henrikson B. Tinnitus as a comorbidity to temporomandibular disorders-A systematic review. J Oral Rehabil 2019;46:87–99.

37. Stevens SS, Davis H. Hearing: its psychology and physiology. New York: John Wiley & Sons; 1938.

38. Tyler RS. The psychophysical measurement of tinnitus. In: Aran JM, Dauman R, editors. Proceedings of the Fourth International Tinnitus Seminar. Amsterdam: Kugler Publications; 1992. p. 17-26.

39. Verdecchia F. Il suono e l'udito. Lynge: Widex; 2007.

40. Woods JW, Theodoroff SM. Cognitive Behavioral Therapy for Tinnitus. Audiology Today; 2019 [Internet]. Available from: https://www.audiology.org/news-and-publications/audiology-today/articles/cognitive-behavioral-therapy-for-tinnitus/ [cited 2023, Jul 21].

41. Yenigün A, Doğan R, Aksoy F, Akyüz S, Dabak H. Assessment of tinnitus with tinnitus severity index, tinnitus handicap inventory and distortion product otoacoustic emissions in patients with normal hearing and hearing loss. Kulak Burun Bogaz Ihtis Derg 2014;24:11–6.

42. Zeman F, Koller M, Figueiredo R, Aazevedo A, Rates M, Coelho C, *et al.* Tinnitus handicap inventory for evaluating treatment effects: which changes are clinically relevant? Otolaryngol Head Neck Surg 2011;145:282–7.

Conflicts of interest

The author certifies that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions

The author read and approved the final version of the manuscript.

History

Manuscript accepted: July 21, 2023. - Manuscript received: June 22, 2023.