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ORIGINAL ARTICLE

Open-field treatment of hyperacusis

Fernando Moliner Peiro,[a,*] Miguel A. López González,[b] Jorge Alfaro García,[a] Jaime Leache Pueyo,[a] and Francisco Esteban Ortega[b]

[a]*Unidad de Otorrinolaringología, Hospital de Día Quirón, Zaragoza, Spain*
[b]*Departamento de Otorrinolaringología, Hospital Universitario Virgen del Rocío, Sevilla, Spain*

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KEYWORDS
Hyperacusis;
Tinnitus;
Open-field

Abstract
Objective: Prospective study of the effectiveness of treatment in patients with hyperacusis by means of an open-field technique of acoustic treatment with nature sounds.
Material and methods: Thirty-four patients were referred to a tinnitus and hyperacusis clinic at a private Otorhinolaryngology Unit. Clinical and exploratory ENT studies were performed. Open-field nature sounds were applied by means of a compact disk for half an hour each day during a period of several weeks.
Results: By the end of treatment, the 34 patients studied had reached normal discomfort thresholds in a maximum of 9 weeks.
Conclusions: The progressive open-field application of nature sounds has been effective in eliminating hyperacusis in a short space of time.

PALABRAS CLAVE
Hiperacusia;
Acufenos;
Campo abierto

Tratamiento de la hiperacusia en campo abierto

Resumen
Objetivo: Estudio prospectivo de la eficacia del tratamiento de pacientes con hiperacusia mediante técnica de tratamiento acústico con sonidos de la naturaleza en campo abierto.
Material y métodos: Acudieron 34 pacientes a consulta de acufenos e hiperacusia de una unidad de otorrinolaringología de una clínica privada. Se realizó estudio otorrinolaringológico clínico y exploratorio. Se aplican sonidos de la naturaleza mediante un disco compacto en campo abierto, media hora al día y durante varias semanas de duración.
Resultados: Al finalizar el tratamiento, los 34 pacientes estudiados consiguieron unos umbrales de malestar normales en un plazo máximo de 9 semanas.
Conclusiones: La aplicación progresiva de sonidos de la naturaleza en campo abierto ha sido efectiva a corto plazo para eliminar la hiperacusia.

*Corresponding author.
E-mail address: fmoliner@able.es (F. Moliner Peiro).

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Introduction

Hyperacusis is defined as an auditory perception of a sound ranging from uncomfortable to painful. Hyperacusis is a hypersensitivity to external sounds, so that everyday sounds from the environment are not tolerated.[1] Put another way, hyperacusis is the reduction of the threshold of tolerance to common environmental sounds. Intolerance to sounds is manifested in the patient by irritability, increase of stress and even social isolation.

Hyperacusis can be distinguished from phonophobia and misophonia. Phonophobia is a mental condition in which the patient has extreme fear (phobia) of certain sounds, which he associates with "something bad" and as a result of these mistaken beliefs, the patient perceives these sounds with much more intensity than they really have, regardless of the sound intensity with which they are expressed. Misophonia is the subjective sensation of annoyance towards sound which does not cause extreme fear, but is rather a negative attitude towards sound.[2,3] These 2 entities are psychological reactions to sound.

Hyperacusis is determined by the discomfort threshold,[1] considering a sound tolerance of 100 dB or more without the presence of discomfort as a normal value.

Various methods have been proposed for the treatment of hyperacusis based on the use of white noise. For example, at home, white noise can be recorded on a compact disc (CD) or mp3 and listened to for 2 hours over 3-6 months, gradually increasing the volume slightly each week, starting with a tolerable volume.[4] Another method takes place in an audiometric booth, in which broadband white noise is used, starting with a tolerable level and increasing it gradually until desensitization is achieved.[5,6]

Use of analogue or digital white noise generators.

Both types of generators would be used for 8 h/day, starting from tolerable sounds and gradually increasing the intensity.[7] The first method[4] is indicated for cases of mild or moderate hyperacusis according to the hyperacusis classification by discomfort threshold[8] (Table) and the other 2[5-7] for severe hyperacusis.

Entities accompanied by hyperacusis include: Bell's palsy and herpes zoster of the ear (absence of acoustic reflexes), vestibular syndromes, Ménière's disease, perilymphatic fistula, craniomandibular disorders, acoustic trauma, head trauma, frequent use of earplugs, Williams[9] syndrome, Tay-Sachs syndrome, as well as psychological and psychiatric alterations.

The aim of this study has been to evaluate the treatment of patients with hyperacusis through sequentially-applied sounds of nature balanced in their frequency.

Materials and methods

Patients

The study was conducted on 102 patients admitted for tinnitus and hyperacusis at the Tinnitus and Hyperacusis Unit, part of the Otorhinolaryngology Department of the Quirón Day Hospital in Zaragoza, from January 2005, to December 2006. A threshold of discomfort or annoyance threshold less than 100 dB was used as the criterion for the inclusion of patients for hyperacusis treatment. If the patient also presented tinnitus, hyperacusis was treated first and then the tinnitus was treated.[10] Of the 102 patients treated at the Unit, 58 presented tinnitus without hyperacusis; 34 tinnitus and hyperacusis, and 10 hyperacusis without tinnitus; therefore 44 patients with hyperacusis were included in the study. All 44 patients with hyperacusis were invited to try the treatment, of whom 34 patients agreed.

Table Classification of hyperacusis based on the threshold of discomfort according to Goldstein and Schulman[8]

Degree	Threshold of discomfort
Negative	>95 dB at all frequencies
Mild	80-90 dB at 2 or more frequencies
Moderate	65-75 dB at 2 or more frequencies
Severe	≤60 dB at 2 or more frequencies

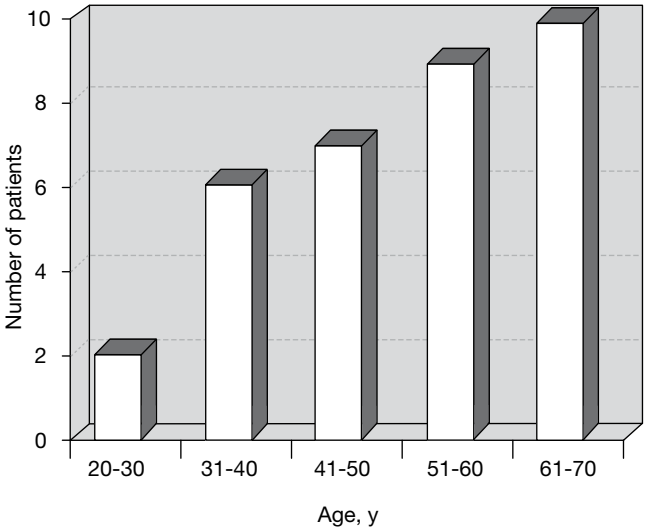

Figure 1 Patients by age groups.

The 34 hyperacusis patients ranged from 29 to 68 years of age, with an average age of 51.4, distributed as indicated in Figure 1. The distribution by gender was 16 females (47.1%) and 18 males (52.9%).

Of the 34 patients with hyperacusis, 16 (47.1%) had hyperacusis, hypoacusis, and tinnitus; 11 (32.3%), hyperacusis, normoacusis, and tinnitus; and 7 patients (20.6%), hyperacusis, normoacusis, and did not present tinnitus. No patients presented hyperacusis and hypoacusis without tinnitus. Of the 16 patients who presented hypoacusis, 9 patients had mild hypoacusis and 7 moderate hypoacusis.[11,12]

Complementary studies

Detailed clinical history and complete otolaryngology examination including otoscopy, rhinoscopy, pharyngoscopy, and fibronasopharyngolaryngoscopy.

Subjective assessment of tinnitus and hyperacusis: Subjective Graduation of Tinnitus Perception,[10] Subjective Graduation of Hyperacusis[9] (both questionnaires give information on the subjective sensation of the patient in relation to tinnitus and hyperacusis), Tinnitus Handicap Inventory[13,14] (THI is a questionnaire on functional, emotional and catastrophic issues emerging in the patient due to tinnitus) and the Digital Visual Scale[10] from 0 to 10 (quantifies the sensation of the patient and shows the degree of discomfort suffered by the patient in relation to hyperacusis).

Audiological examinations: impedanciometry, pure tone threshold audiometry, discomfort threshold (measurement of tinnitus in those cases presenting tinnitus in order to monitor their treatment), logoaudiometry, troncocochlear auditory evoked potentials, computerized tomography, and/or magnetic resonance imaging (MRI) of internal auditory canals with gadolinium (in fact, prior to inclusion in the Tinnitus and Hyperacusis Unit, of the 102 patients, 2 patients presented neurinomas and 1 patient meningioma, which led them to be referred to neurosurgery).

The basis for the diagnosis of hyperacusis is the determination of the discomfort threshold. This is defined as the maximum threshold for tolerance towards sound, tested in an audiometry booth for each ear and with the measurements being carried out on 2 occasions in each ear alternately, with 100 or more decibels being the normal average for each frequency.[1]

Sound treatment

The sound treatment is done with sounds from nature balanced in symmetry and frequency (ocean waves, sounds of water flowing) and applied sequentially in an open field setting. The patient sits at a distance of about 1-1.5 m from the speakers (not headphones), always at the same distance during the sound treatment, for half an hour daily and performing a manual activity that does not require excessive attention (such as reading, knitting, or doing simple puzzles).

These sounds from nature are recorded on a CD. Playback takes place on a digital device that has an intensity of 5 dB at each volume level. To this end, a sound study was carried out on the level of decrease and increase in the volume potentiometer of the digital CD players. The study was conducted with the Brüel & Kjaer sound level meter Type 2235 (Serial nº 1608500, IEC 651 Type 1, DIN IEC 651 class 1 and ASI S1.4-1986 Type 1, Precision Sound Level Meter Type 2235, Wirh Microphone Type 4176, Germany). The method was to measure the increase and decrease in the level of the potentiometer for 10 digital players of different brands and models using the same CD with music from nature, and on the same 30 s of the same track. Once the measurement was carried out as described above and the average of the 10 devices was taken, we obtained a difference of 5.1 dB between potentiometer levels.

The procedure was as follows: the patient started the treatment by setting the sound volume to the minimum level causing discomfort, noting the volume and beginning 4 levels (20 dB) below the disturbing volume for the first week. On subsequent weeks the volume was increased one level (5 dB) until a normal tolerance to sound was reached (100 dB or more).

The practical way of doing this is as follows: the patient must play the CD with sounds from nature on a digital CD player and raise the volume up to the level where it causes discomfort and note the volume digit (eg, 12), then decrease the volume by 4 digits (in this example, the volume would be 8) and the treatment should begin from that sound level. This is the way to decrease the minimum level of sound intensity producing discomfort by 20 dB.

Continuing with the example of the minimum discomfort level of 12 and decreasing the volume by 4 digits, the starting point would be at volume level 8, with the following mechanics:

- Week 1: half an hour daily with the sound level at digit 8
- Week 2: half an hour daily with the sound level at digit 9
- Week 3: half an hour daily with the sound level at digit 10
- Week 4: half an hour daily with the sound level at digit 9
- Week 5: half an hour daily with the sound level at digit 10
- Week 6: half an hour daily with the sound level at digit 11
- Week 7: half an hour daily with the sound level at digit 10
- Week 8: half an hour daily with the sound level at digit 11
- Week 9: half an hour daily with the sound level at digit 12

If at any time during treatment there is discomfort with the noise level being listened to following the proposed pattern, then the sound level of the previous week should be repeated and then the pattern should be resumed. This is only a possibility, as it has not occurred with any of the patients.

Results

Of the 34 patients treated, 33 patients achieved a normal threshold for discomfort (100 dB) at the end of the treatment. One patient did not recover a normal discomfort threshold. This patient acknowledged that he was unable to follow the proposed method, so it was suggested that he should follow the same pattern but with a white noise generator and, after 9 weeks, he recovered a normal discomfort threshold.

The patients managed to reach the normal discomfort threshold after treatment for 9 weeks, with no significant differences being observed between patients with hypoacusis and normoacusis, nor between patients with or without tinnitus. Two months after completing the treatment, a new measurement of the discomfort thresholds was carried out and they were normal in all cases.

The mean frequency of the discomfort thresholds prior to the start of treatment was: 250 Hz: 69.24 dB and $P<.00459$ for Student t test; 500 Hz: 68.934 dB and $P<.00461$ for Student t test; 1000 Hz: 70.15 dB and $P<.00453$ for Student t test; 2000 Hz: 70.60 dB and $P<.00450$ for Student t test; 4000 Hz: 70.60 dB and $P<.00450$ for Student t test; and 8000 Hz: 70.30 dB and $P<.00452$ for Student t test. After treatment, the discomfort thresholds reached 100 dB at all frequencies (Figure 2).

Following Goldstein's classification of hyperacusis (Table), the patients with hyperacusis were divided into mild hyperacusis (3 patients), moderate hyperacusis (20 patients), and severe hyperacusis (11 patients).

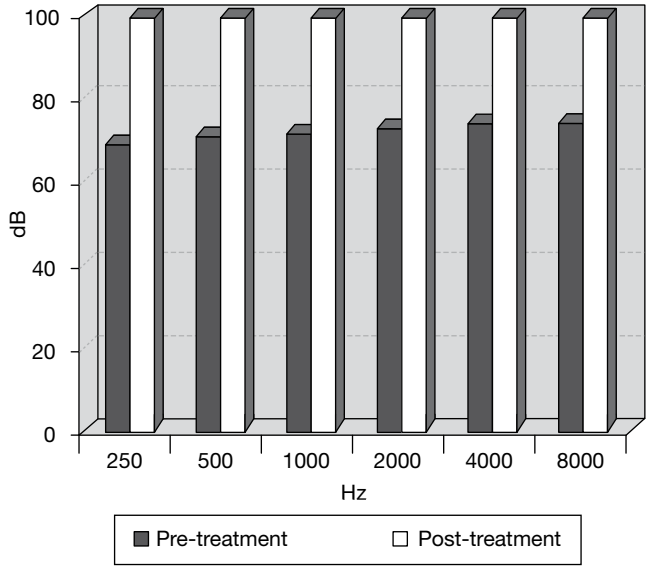

Figure 2 Discomfort thresholds by frequency. Statistically significant pre- and post-treatment Student *t* test with *P*<.001.

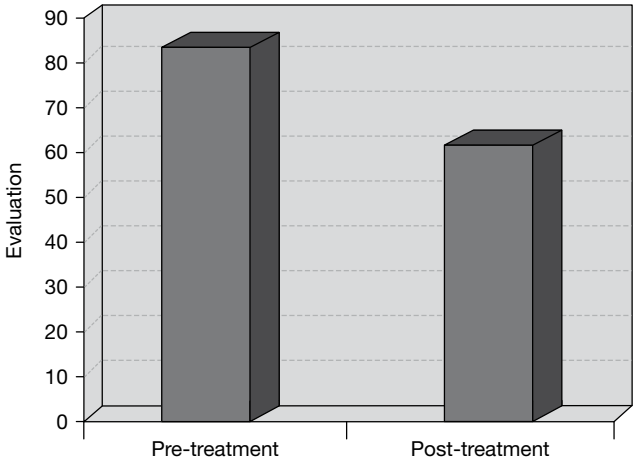

Figure 3 Evolution of the Tinnitus Handicap Inventory in patients with tinnitus and hyperacusis pre-treatment and post-treatment. Statistically significant pre- and post-treatment Student *t* test with *P*<.001.

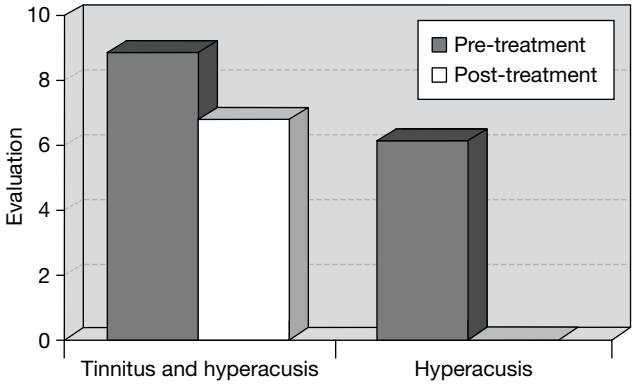

Figure 4 Pre- and post-treatment progress on the visual digital scale for patients with tinnitus and hyperacusis or hyperacusis. Statistically significant pre- and post-treatment Student *t* test with *P*<.001.

After treatment, the patients underwent other subjective tests, such as Subjective Graduation of Tinnitus Perception, with 4 levels of response (increases, continues as usual, decreases, disappears). In all cases, the perception of tinnitus decreased after treatment. The Subjective Graduation of Hyperacusis was also performed, also with 4 levels of response (increases, continues as usual, decreases, disappears) and, in all cases, discomfort due to hyperacusis disappeared.

The THI was given to patients with tinnitus and hyperacusis before and after treatment, with the results going from a mean of 88.72 to 66.78 points, and with a statistically significant Student *t* test pre- and post-treatment, with *P*<.001 (Figure 3).

The Visual Digital Scale was also determined before and after treatment in patients with tinnitus and hyperacusis, who went from an average of 8.87 to 6.93 points, and an average of 6.15 that went to 0 points, in those who only had hyperacusis; Student *t* test was statistically significant pre- and post-treatment, with *P*<.001 (Figure 4).

Discussion

This treatment method is simple, as described previously: availability of a CD with sounds from nature balanced in frequency, half an hour daily during 9 weeks and performing a calming activity.

All other proposed treatments require either more sophisticated (audiometric booth) or more expensive (white noise sound generators) technical resources, or else longer periods each day (white noise recorded on CD for 2 h/day, white noise generators 8 h/day) and a much longer treatment period (between 3 and 6 months). Knaster[5] and Domínguez et al[6] have administered broadband or narrowband sounds and obtained an improvement in discomfort thresholds in between 59% and 94% of cases. Jastreboff (2003)[14] place white noise generators, in the framework of the Tinnitus Retraining Therapy, for 8 h/day, beginning with a tolerated volume and increasing it slowly. In a series of 130 patients, Gold et al[15] reduced the discomfort threshold by more than 12 dB for frequencies of 2, 3, and 4 kHz, and in the study by Hazell et al,[16] 45% of patients normalized their threshold in 6 months, and 61% in 25 months. Herráiz[4] achieves this through the application of white noise at home, administered in the form of a CD or mp3 continuously for 2 h a day for 3-6 months. The initial volume should be perfectly tolerable, gradually increasing slightly each week, for mild and moderate hypoacusis, while white noise generators should be used for severe hypoacusis.

The method proposed, in addition to being an inexpensive, simple and short-lasting treatment, can be applied to hyperacusis of any degree and aetiology. This method has been effective in 97% of the cases treated.

Conclusions

This method of gradual desensitization through sound treatment using sequentially-applied sounds from nature balanced in frequency in the open field may be carried out on hyperacusis patients regardless of the aetiology of their hyperacusis, the patient's hearing or any additional disorder such as tinnitus. The time required to achieve noise tolerance is shorter than with other methods. In addition, for patients with hypoacusis, the sound treatment for hyperacusis can be beneficial as auditory training[5] for the fitting of hearing aids at a later stage, if there is hearing loss.

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