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BRIEF COMMUNICATION

Extended High-frequency Audiometry (9000–20 000 Hz). Usefulness in Audiological Diagnosis☆

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Abstract Early detection and appropriate treatment of hearing loss are essential to minimise the consequences of hearing loss. In addition to conventional audiometry (125–8000 Hz), extended high-frequency audiometry (9000–20 000 Hz) is available. This type of audiometry may be useful in early diagnosis of hearing loss in certain conditions, such as the ototoxic effect of cisplatin-based treatment, noise exposure or oral misunderstanding, especially in noisy environments. Eleven examples are shown in which extended high-frequency audiometry has been useful in early detection of hearing loss, despite the subject having a normal conventional audiometry. The goal of the present paper was to highlight the importance of the extended high-frequency audiometry examination for it to become a standard tool in routine audiological examinations.

PALABRAS CLAVE
Audiometría con extensión en altas frecuencias;
Hipoacusia;
Tinnitus;
Presbiacusia;
Cisplatino

Audiometría con extensión en altas frecuencias (9.000-20.000 Hz). Utilidad en el diagnóstico audiológico

Resumen La detección precoz y el tratamiento adecuado de la hipoacusia es fundamental para minimizar las consecuencias de la pérdida auditiva. Además de la audiometría convencional (125-8.000 Hz), disponemos de la audiometría con extensión en altas frecuencias (9.000-20.000 Hz), que puede ser de gran utilidad en el diagnóstico precoz de hipoacusia en ciertas patologías, como es el efecto ototóxico de los tratamientos quimioterápicos, la exposición a ruido o el mal entendimiento del lenguaje, especialmente en ambientes ruidosos. Aquí

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se presentan 11 casos clínicos en los que la audiometría con extensión en altas frecuencias ha ayudado en la detección precoz de la hipoacusia en diversas patologías, a pesar de tener una audiometría normal en frecuencias convencionales. Se pretende así destacar la importancia de la exploración audiométrica en altas frecuencias, con el fin de que se convierta en una herramienta habitual en la exploración audiológica.

Introduction

Many factors are known to affect hearing, such as age, exposure to noise and taking potentially hearing-toxic drug. Both early detection of hearing loss and early intervention are essential to minimise hearing loss.

Hearing is assessed through conventional tonal audiometry (125–8000 Hz). However, the human ear possesses an auditory range that reaches up to 20 000 Hz. Frequencies between 9000 and 20 000 Hz are called *extended high frequencies* (EHFs) in the international literature. Castilian Spanish has no defined equivalent term; such frequencies are called *high frequencies*, *ultra-high frequencies* or *extended high frequencies* by different authors, with the last term being the one that we are going to use to refer to them.

The involvement of EHFs in auditory pathology is multiple. They can affect locating the sound[1] and understanding language, especially in noisy surroundings.[2,3] They have also been linked with age-related hearing loss, ototoxicity and acoustic trauma. The ability to hear reduces bit by bit with age; this loss begins at the highest frequencies and progressively extends toward the lowest frequencies. The EHFs consequently become of special importance in age-related hearing loss, as a method for early detection of such loss.

An important role is played by EHF audiometry in monitoring the ototoxic effect of drugs such as cisplatin, which produces an initial hearing loss in the EHF range, later affecting conventional frequencies.[4] However, the usefulness of EHF audiometry compared with conventional frequencies in early detection of acoustic trauma is still being debated.[5–8]

Reference hearing thresholds distributed by age groups have recently been published for both conventional frequencies[9] and EAF.[10,11] These values let us compare a subject's hearing with the standard for an otologically normal population and establish the extent to which the subject's hearing departs from normality expressed as a percentile. We can thus evaluate patients being treated with chemotherapy or exposed to noise that report a hearing loss and for whom there is no prior audiometry available.

The objective of this study was to emphasise the importance of EHF audiometry, to help to make it a normal tool in audiological examination. To do so, we present a series of clinical cases in which this type of audiometry has aided in early detection of various pathologies.

Methods

Subjects

The data for 11 subjects that consulted with suspicion of auditory pathology have been gathered. Each subject's audiometry at conventional frequencies was normal, and we performed an EHF audiometry on all the subjects (Table 1). The patients selected presented several pathologies that can cause hearing loss over the evolution of the disease.

Instrumental and Procedure

All selected subjects received air-conduction pure-tone audiometry to determine the hearing threshold at different frequencies (125–20 000 Hz). The audiometric results obtained were compared with the previously-published normal Spanish population values at conventional frequencies[9] and at EAFs.[10]

For the conventional frequency audiometry at conventional frequencies (125–8000 Hz), a Madsen Orbiter 922 clinical audiometer and supra-aural Telephonics TDH-39 earphones were used. The EHF audiometry (9000–20 000 Hz) was performed with the same audiometer and Koss HV/1A circumaural earphones. All the audiometric material was calibrated according to the manufacturers' recommendations as well as to ISO 389-1[12] and IEC 60645-1[13] standards. The transducers were calibrated according to ISO 389-1[12] standards.

The audiometry was performed manually by trained personnel, in agreement with ISO 8253-1[14] standards, within a sound-proof booth. Auditory thresholds were determined based on the ascending method established in ISO 8253-1[14] standards. The thresholds at the conventional frequencies were calculated in decibels hearing level (dB HL) and the thresholds at EHFs, in dB sound pressure level (dB SPL).

Results

Table 1 presents a summary of the characteristics of the subjects on which audiometry was performed using both conventional frequencies and EHFs.

Cases 1, 2, and 3 presented normal hearing levels up to 8000 Hz, with a drop to under the 95th percentile (P95) for their age group (20–29 years) at the frequencies from 9000 Hz (Fig. 1).