A MODEL OF THE HUMAN HEARING SYSTEM TO REPRODUCE THE MOST COMMON PATHOLOGIES

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ABSTRACT

In this study it is described an acoustic measurement method which tries to solve current issues in determining the main pathologies of human auditory system. For example, the Eustachian tube is the only natural communication between the middle ear and the external environment, this contributes to facilitate the transmission of sound in the middle ear keeping a good balance of pressures. Poor ventilation probably contributes to the development of most cases of otitis media. Through this model it is possible to represent these particular cases. In this study contributions from previous publications were examined. In those papers, the external auditory conduct, the middle ear and the cochlea were modeled to determine the acoustic measurements of ear. In contradistinction to most previous studies, the model developed in this study fits the individual data instead of average data, for human healthy and unhealthy ears. The results are compared with other previous studies.

Keywords: Hearing system, acoustic measurement.

INTRODUCTION

Among the acoustic measurements, the ear acoustic input impedance quantifies how this organ receives sound. The external auditory conduct, the middle ear and the cochlea contribute to this acoustic input impedance. Measuring this variable is a fundamental from the point of view of the basic investigation, and from the standpoint of clinical diagnosis. Regarding the first point, the characterization of the amplification factor of the middle ear is crucial for the process of knowing how to operate the auditory system, when the input and output signals are given. From a clinical point of view, it is essential for a correct diagnosis to be able to separate the problems associated with the transmission of the middle ear caused by cochlear pathologies.

In the auditory system, the Eustachian tube is the only natural communication between the middle ear and the external environment, represented by the nasopharynx. The most important function of the Eustachian tube is the ventilation of the middle ear in order to balance the air pressure with atmospheric pressure, and to replenish the oxygen when it has been absorbed. Thus, it is reached a good impedance from timpanic-ossicular system, and therefore a decrease of resistance, protecting the auditory organ of sudden pressure fluctuations. Normally, the Eustachian tube remains closed, opening it briefly with swallowing (or the Valsalva maneuver) for a half a second approximately. When the tube is closed within a long period of time (cold symptoms), the middle ear pressure is highly negative, mainly due to the reabsorption of oxygen from the cavity through the mucosal capillaries, which leads to...
retraction of the tympanic membrane and, if this situation continues, a transudate will occur to the cavity from the mucosal vessels, causing increased resistance and therefore an increase of impedance from the middle ear.

In this study it is developed an adaptation model that responds to both, that last case and other abnormal functions of the auditory system.

RESULTS AND CONCLUSIONS

The results of this work are shown in Fig. 1 where the magnitude of the input impedance is seen. It can be observed a wide variation in the magnitude of the input impedance acoustic. Fig. 1 (a) shows a normal ear, whereas in Fig. 1 (b) it is shown the changes produced in the middle ear by increasing the stiffness or decreasing the compliance. In both cases, model fits correctly.

Fig. 1(a) -Input Acoustic impedance for two particular cases of human ears – a) normal ear, b) abnormal functions of the auditory system
This work shows that there are substantial differences in the characterization model for each case of study. Other experiments must be carried out to analyze resonance points, in order to get a better fit of data (phase peaks).

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REFERENCES


