MEASUREMENTS OF ACOUSTIC IMPEDANCE IN INDIANS

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Abstract

Impedance measures—tympanometry, acoustic impedance, and acoustic reflex threshold were determined on 136 Indian subjects (191 ears) using electro-acoustic bridge (Madsen ZO 70). The subjects included normal and pathological, varying in age from 6-56 years. Sex and age differences were observed with regard to static compliance and acoustic impedance. Any conclusion regarding the norms for acoustic impedance cannot be drawn as there is overlapping of pathogical and normal ears with regard to acoustic impedance. The normals obtained a wider range of 682-5840 acoustic ohms. Varying of air pressure in the ear canal had significant effect on acoustic reflex threshold.

The concept of *impedance* was introduced in 1914 (Webster 1919). Its application to clinical audiology became evident from the day Metz (1946) published his classic monograph—'The Acoustic Impedance measured on Normal and Pathological ears'. Today, Acoustic Impedance measured at the tympanic membrane is "- - - not just another audiological test"—it constitutes—a whole new field of investigation with an inherent new methodology". (Zwislocki, 1965).

Currently, acoustic impedance measurements constitutes the only means of direct examination of the middle ear function. They are performed at physiological vibration amplitudes and, therefore, give a direct estimate of the efficiency of the sound transmission. Except in acoustic reflex threshold tests, the sensorineural part of the auditory system is not involved.

The acoustic impedance method is based on a partial reflection of sound. It depends not only on the structure of the tympanic membrane but also on that of the middle ear components and cochlea. Through acoustic measurements on normal and pathological ears and with the help of anatomy and acoustic theory, it is possible to analyze the middle ear function in detail and to correlate the acoustic charges measured at the tympanic membrane to middle ear pathologies. In a way impedance audiometry helps to look beyond the intact tympanic membrane and it tells about the sound transmitting characteristics of the middle ear.

There appear to be numerous studies to estadlish norms for impedance measurements by using both Zwislocki's bridge and the electro-acoustic bridge. Still there is scarcity of normative data and the available results show discrepancy for both the methods. Jerger *et al* (1972) in comparing normative data from six sources, three studies using Zwislocki's bridge and three studies using electro-acoustic bridge found variations.

Normative data are very important for the classification of ears under test into normal

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or abnormal. The classification of the ear into normal and abnormal depends on which normative data was used for the comparison

In view of all these it was decided to study the impedance values in Indian population.

Methodology

Subjects

136 subjects (191 ears) were tested. Table 1, gives the frequency distribution of the subjects.

TABLE 1

Sl. No.	Group	Age range	Mean age	No. of sublects	No. of ears
1	5-14 yrs. (boys)	6-14	8.85	7	13
2	5-14 yrs. (girls)	6-13	8.66	6	11
3	15-29 yrs. (males)	17-29	20.96	30	47
4	15-29 yrs. (females)	16-29	21.32	25	52
5	30-50 yrs. (males)	30-49	38.00	16	30
6	S.N. loss	12-56	——	14	20
7	C.L. other than Otosclerosis			18	28
8	Otosclerosis			8	13
9	Mixed loss			11	18
10	Functional loss			1	1

Apparatus

Madsen ZO 70 electro acoustic impedance bridge was used. To measure the acoustic reflex threshold an audiometer (Madsen) was used along with the impedance bridge.

The procedure used for administering the Impedance Audiometry was same as the procedure given in the manual (Manual of Madsen electroacoustic impedance bridge model ZO 70 published by Madsen Electronics). Regarding tympanometry, due to the non-availability of the X-Y Plotter, the following procedure was designed to obtain the tympanograms: Sensitivity Control was set to position 1. Pump control was rotated until the monometer read 400 mm H_2O. At this pressure the compliance control was adjusted until the balance meter was nulled and the compliance reading on the compliance scale (in equivalent volume in cc) was acorded. Pump control was rotated until the monometer read 360 mm H_2O. At this pressure compliance control was adjusted to null the balance with (if required) and the compliance reading with compliance scale was recorded.

This procedure of varying the pressure in steps of 40 mm. H_2O was repeated until the monometer showed +200mm. H_2O. Each time the pressure was varied, the balance meter

was nulled by adjusting the compliance controlled the corresponding reading on the compliance scale was recorded.

By using two compliance values i e., (1) the minimum compliance (C_1) recorded and (2) the compliance value (C_2) obtained at +200 mm H_2O pressure, the static compliance (C_s) for the subject was computed : $C_s = C_2 - C_1$

Results and Discussion

1 Comparison of two groups (boys and girls) in the age range of 5-14 years shows no significant difference with regard to static compliance indicating no sex difference in younger age groups. This is in agreement with other studies.

2 Comparison of the two adult groups (males and females in the age range of 15-29 years shows significant difference with regard to static compliance indicating sex difference. The males show higher compliance than the females. This agrees with the reported studies.

3 Comparison of the two male groups on the age of 15-29 aged 30-50 years respectively, shows significant difference in compliance indicating age difference. Compliance declines as a function of age. This conforms with the previous reports.

4 The average compliance and the variance in compliance are more with female than male.

5 There is significant difference in acoustic impedance between girls and boys indicating sex difference in early age groups. The former groups shows higher impedance than the latter. This result is not in agreement with the conclusion number one. It need further investigations.

6 There is no significant difference with regard to acoustic impedance between males and females for the same group (15-29 years). This result also is not in agreement with the conclusion number 2. Further investigations are needed.

7 There is significant difference with regard to acoustic impedance between two male groups, viz., 15-29 and 30-50 years, indicating age difference in acoustic impedance. The older age group shows higher impedance than the younger group. This is in agreement with the compliance results that it declines with age.

8 Acoustic reflex was observed in 100 per cent cases only at 1 KHz and 2KHz for all the normal ears.

9 Reflex threshold declines with increase in threshold of hearing in sensorineural loss.

10 Any conclusion regarding the norms for acoustic impedance cannot be drawn as there is overlapping of pathological and normal ears with regard to acoustic impedance. The normals obtained a wide range of 682-5840 acoustic ohms

11 All conductive and mixed loss cases showed absence of acoustic reflex.

12 Suspected otosclerotic ears (16) obtained impedance score in the range of 1032 to 7552 AC ohms. The mean value is well above the mean for normal ears.

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