Tympanometric profiles for Chinese older adults

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Abstract

The current study aimed at obtaining and examining the normative tympanometric findings in the Chinese older adults (60 to 90 years). The tympanometric data was collected using the Interacoustics Titan IMP 440 clinical immittance meter. This included peak static acoustic admittance (Ytm); tympanometric peak pressure (TPP); tympanometric width (TW); and ear canal volume (ECV). 146 (228 ears) Chinese older adults with normal hearing or sensorineural hearing loss were included in the study.

The mean and standard deviation of the tympanometric values include: Ytm 0.48±0.28mmho; TPP -5±11daPa; TW 74±27daPa; and ECV 1.06±0.29 cc. Factors such as ear, gender and age had a minimal effect on all the four-tympanometric parameters studied. Nevertheless, there were a few differences between the present study results and the previously published data. The study results warrant the need for population and age specific normative values for clinical use.

Introduction

Tympanometry is a gold standard test to assess the function of the middle ear. Traditionally, in adults it is tested using a 226 Hz pure tone while varying the air pressure in the ear canal. Although age specific tympanometric norms were developed in Caucasian population[1-3] they have only been established for children or young adults in the Chinese population.[4,5]

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It is unclear whether the middle ear transmission system is affected by the age as previous studies have reported mixed results.[5-9] It has been shown that tympanic membrane and middle ear structures undergo anatomical changes in older adults.[10] These changes can often influence tympanometric measures and it is therefore imperative to use age specific norms.

Ethnicity is another variable that can affect tympanomteric data. Wan & Wong[4] used standard 226 Hz tympanometry to compare norms in young Chinese adults with the data obtained from the Roup *et al.*[11] study in Caucasian adults. Their results found that the Chinese adults had lower peak compensated static acoustic admittance (Ytm), wider tympanometric width (TW) and more positive tympanometric peak pressure (TPP) compared to Caucasian adults from Roup *et al.*[11] study. Shanaz and Dreena[2] studied standard and multifrequency tympanometry norms in Chinese and Caucasian young adults and found that Chinese adults had significantly lower Ytm, wider TW, more positive TPP and lower ear canal volume (ECV) compared to Caucasian counterparts. However, the mean ECV values for females are not significantly different between these two groups. The authors attributed the reasons to the differences in the size of the middle ear and the ear canal. From these studies, it is plausible to assume that tympanometric values in older Chinese adults can differ from the established normative data. Yet, no normative values in this population are available. The current study aimed at obtaining and examining the normative tympanometric values in Chinese older adults (60 to 90 years). The effect of ear, gender and age was examined on immittance measurements such as Ytm, ECV, TPP and TW.

Materials and Methods

Study design and participants

Ethical approval was obtained from National Health Care Group-Domain Specific Review Board, Tan Tock Seng Hospital, Singapore. The study sample included older adults with normal hearing or sensorineural hearing loss. They were recruited consecutively from the Department of Audiology, Tan Tock Seng Hospital, Singapore during their audiological consultation. All the subjects who participated in the study had a negative history of external or middle ear pathology, no evidence of occluded ear wax or structural abnormality and a gap of less than or equal to 10 dB between air and bone conduction thresholds in at least one ear. Participants that did not meet these criteria in both ears were not involved in the study. All the participants were Singapore or China born Chinese individuals.

One hundred-forty six participants (223 ears - 115 right ears, 118 left ears) were selected for the study. There were 74 females

and 72 males with mean age and standard deviation of 70.00±7.3 years (range of 60 to 90 years).

Procedure

Pure tone air and bone conduction audiometry was conducted at all applicable octave frequencies using using a Gradson-Stadler GSI-61 or Interacoustics AD 229 standard clinical audiometer. Audiometers were calibrated as specified by ANSI standards[12] and the noise level in the testing room was within permissible limits.[13] For tympanometry, an Interacoustics Titan IMP 440 clinical immittance meter was used in the present study. Before the data collection, a calibration was performed on a 2 cc cavity to check if the system worked within the limits of the manufacturer specifications. Tympanometry was performed using 226 Hz pure tone with the pump speed set to medium (200 dapa/second). The pressure was swept from positive +300 daPa to negative –300 daPa and the recordings were taken once in each ear for every participant. If there is a 'B' tympanogram or if the ear canal volume is too low, measurement was repeated again to check for the reliability of the test. The order of testing was counterbalanced. Measures of ECV, Ytm, TW and TPP were obtained. ECV is the height of the tympanogram measured at the extreme pressure (+300 dapa). Ytm refers to the peak admittance minus the value to +300 daPa. TW is the width of the tympanogram measured at 50% of the tympanogram. TPP refers to the pressure point that corresponds to the maximum height of the tympanogram.

Data analysis

Statistical Package for the Social Sciences (SPSS) version 17 was used for data analysis. Descriptive statistics was explored. Assumptions for normality and homogeneity of variance were tested. T- test was used to compare mean differences between the ears, gender, and to study the age effect. P-value of 0.01 was used for interpretation of significance. Bonferroni corrected P-value of 0.002 was used for significance test for multiple comparisons.

Results

Tympanometric profiles in Chinese older adults

Table 1 displays the mean, standard deviation (SD), and 90% range values for the test of peak static acoustic admittance (Ytm), tympanometric peak pressure (TPP), tympanometric width (TW), and ear canal volume (ECV). Some of the TPP and TW values have been rounded to the nearest whole number. Slight but significant effects were observed between the ears, gender, and age bands. Hence, the normative values presented in Table 1 have been given in a collapsed format.

Comparison between the ears

Paired sample *t*-test was performed to examine if the tympanometry values differ between the ears (Table 2). Results suggested no significant difference (using Bonferroni corrected P-value for significance interpretation) between the right and left ear in all the four-tympanometric parameters.

Gender effect

Independent sample *t*-test was performed to explore the difference in tympanometric values between males and females (Table 3). Results suggested no significant difference between the male

Table 1. Normative tympanometric data for 223 ears of Chinese older adults (60-90 years).

Variables	Mean	SD	90% range
Peak static acoustic admittance (Ytm) in mmho	0.48	0.28	0.20 to 0.86
Tympanometric peak pressure (TPP) in daPa	–5	11	–19 to +7
Tympanometric width (TW) in daPa	74	27	37 to 109
Ear canal volume (ECV) in cc	1.06	0.29	0.72 to 1.40

Table 2. Tympanometric values between right and left ears (Mean, SD and t test results).

Variable	Mean±SD	*t*	df	Sig.
Ytm (mmho)	Right ear: –3.39±8.7 Left ear: –4.97±11.6	0.65	86	0.52
TPP (daPa)	Right ear: 0.47±0.26 Left ear: 0.46±0.26	1.45	86	0.15
TW (daPa)	Right ear: 72.08±25.9 Left ear: 77.84±25.4	–2.33	86	0.02
ECV (cc)	Right ear: 1.05±0.290 Left ear: 1.06±0.32	–0.36	86	0.72

Table 3. Tympanometric values between males and females (Mean, SD and t test results).

Variable	Mean±SD	*t*	df	Sig.
Ytm (mmho)	Males: 0.51±0.30 Female: 0.44±0.26	1.87	231	0.063
TPP (daPa)	Males: –4.80±9.02 Female: –4.82±11.7	0.02	231	0.98
TW (daPa)	Males: 72.7±27.3 Female: 74.5±26.5	–0.52	231	0.60
ECV (cc)	Males: 1.12±0.28 Female: 1.01±0.28	3.12	231	0.002*

*Statistical significance when using the Bonferroni corrected P-value.

and female participants for the tympanometric parameters Ytm, TPP and TW. However, there was small (*i.e.*, 0.11 cc) but statistically significant difference in ECV between males and females.

Age effect

The sample was divided into three sub-categories (*i.e.*, 60-69 years; 70 to 79 years; and 80 years and above) based on the age. Independent sample Kruskal-Wallis test was performed to study the age effect in terms of tympanometry values. No statistical significance was seen with Ytm (P=0.159), TPP (P=0.158), TW (P=0.111) and ECV (P=0.068), suggesting the distribution of these tympanometric measures did not vary across age bands.

Comparisons with other studies on Chinese population

Table 4 presents the tympanometric values of the Chinese population from current study compared to the younger population data from published studies. One sample *t*-test was performed to examine if any difference in tympanometric values exist between the current study samples when compared with younger adults and schoolchildren taken from previously published studies (Table 4). Some differences were observed in all the four-tympanometric parameters when compared to younger population.

Discussion

The present study investigated the tympanometry normative values in Chinese older adults. No gender effect was evident except for ECV with males having slightly higher mean value compared to their female counterparts. These results are consistent with the Wan & Wong[4] and Li *et al*.[5] studies but appear to be in contrast to the Shanaz & Dreena study.[2]

Current study did not find any significant differences between right and left ears in any of the tympanometric parameters. Results obtained are in accordance with the Wan & Wong[4] study where the authors did not find any ear effect. On the other hand, Li *et al*.[5] found slight but significantly larger ear canal volumes in the left ear and attributed the disparity to the way the tester may have handled the instrument differently between right and left ears. Furthermore, Goldling *et al*.[3] study showed significantly lower Ytm values in the left ear for both men and women. They suggested that the middle ear system might age differently between both ears.

In comparison to the other Chinese population studies, the upper end of the 90% range for Ytm was found to be smaller in the present study compared to younger groups. Also, both Wan & Wong[4] and Li *et al*.[5] findings showed statistically higher mean Ytm values compared to the present study. These results suggest that the admittance values decrease with age due to the age related physiological changes of the middle ear. Similarly, the upper 90% range for ECV was found to be smaller in the current population compared to younger Chinese. Surprisingly, the TW was found be significantly narrow in the present study group compared to younger groups and this could probably be due to the use of different instruments and pump speed. For TPP, the lower range of the 90% value was comparable to other studies but the upper range was found be smaller. These findings supports the fact that the eustachian tube function does not change with age.

When compared to other older Caucasian population, elderly Chinese had significantly smaller ECV, lower Ytm and narrower TW and TPP. These findings support the fact that the normative data obtained in older Caucasians may not be appropriate to apply in an older Chinese population.

Conclusions

The current study revealed slight but statistically significant differences in ECV between males and females. Neither ear nor age effect was noticed in any of the tympanometric values. Examination of 90% range values suggests that older Chinese had lower admittance and narrow TW compared to Chinese young adults and children from other studies. Although the difference in tympanometric values between the younger and older groups are marginal, they were found to be statistically significant. These results suggest the need for having population specific and age specific normative values for clinical use especially when using the instruments norms from a Caucasian population.

Table 4. Comparison of current study results with previous studies on Chinese population.

Population	Study results				Comparison of previous studies with current study: t value (*Sig.)		
	Current study	Shanaz & Dreena (2006)	Wan & Wong (2002)	Li *et al.* (2006)	Comparison with with Shanaz & Dreena (2006)	Comparison study Wan & Wong (2002)	Comparison with Li *et al.* (2006)
Population	Older adults	Young adults	Young adults	Schoolchildren	-	-	-
Age (years)	60-90	18-34	19-34	6-13	-	-	-
N (ears)	233	160	200	538	-	-	-
Peak Ytm (mmho)	0.48±0.28 (0.20 to 0.86)	0.47±0.29 (0.20 to 1.10)	0.55±0.28 (0.20 to 1.10)	0.58±0.34 (0.26 to 1.13)	0.36	–4.04*	–5.70*
TPP (daPa)	–4.8±10.5 (–19 to +6.6)	–0.6±13.8 (–18 to +18.9)	–3.9±18.4 (–19 to +25)	–25±30 (–85 to +10)	–6.12*	–1.32	29.34*
TW (daPa)	73.6±26.9 (37 to 109)	109.2±29.1 (66 to 158)	91.2±31.8 (45 to 159)	112±36 (62 to 156)	–20.2*	–9.98*	–21.8*
ECV (cc)	1.06±0.29 (0.72 to 1.40)	1.02±0.32 (0.60 to 1.60)	1.17±0.28 (0.80 to 1.60)	1.03±0.25 (0.68 to 1.46)	2.31	–5.62*	1.78

*P≤0.001.

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