Original Article

Effects of Ethnicity and Gender on the Middle Ear Function in Asian Adults

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Abstract

Introduction: Tympanometry is a standard clinical test to measure the middle ear function objectively. Ethnicity and gender may affect tympanometric results, and specific normative data are required for diagnosing middle ear disorders accurately. **Aim:** This study aimed to determine the effects of ethnicity (Malay vs. Chinese) and gender on tympanometric results among Asian adults. **Materials and Methods:** A total of 72 young adults aged 20–25 years participated in this comparative study. They comprised two ethnic groups: Malay ($n = 31$ [14 males and 17 females]) and Chinese ($n = 41$ [20 males and 21 females]) participants. All participants fulfilled the inclusion criteria (no history of ear and hearing difficulties and normal findings in routine audiological assessments) and underwent a standard 226 Hz tympanometric testing. Tympanometric parameters including static admittance (SA), ear canal volume (ECV), tympanometric peak pressure (TPP), and tympanometric width (TW) were recorded from each participant. **Results:** No significant differences in all tympanometric parameters were found between Chinese and Malay participants ($P > 0.05$). However, statistically higher SA and ECV values were noted in males than in females ($P < 0.05$). No gender effect was observed in TPP and TW ($P > 0.05$). **Conclusions:** For a more accurate middle ear evaluation in Malay and Chinese young adults, gender-specific tympanometric normative data derived from this study are recommended.

Keywords: Asian, ethnicity, gender, tympanometry

Introduction

Hearing loss is common among adults and children.[1-3] If the external ear or middle ear is compromised, conductive hearing loss (CHL) occurs. Tympanometry offers an objective and convenient way to diagnose CHL. Specifically, it measures the middle ear functions that are often compromised in CHL cases.[4,5] It has been found to be highly sensitive in identifying various middle ear disorders.[6,7] In fact, tympanometry has been included as part of the routine audiological test battery in providing clinical services for decades.

To determine the middle ear functions, tympanometric parameters including static admittance (SA) (ml), ear canal volume (ECV) (ml), tympanometric peak pressure (TPP) (daPa) and tympanometric width (TW) (daPa) are used. Each of these parameters has specific diagnostic values. For instance, in typical cases of otitis media with effusion, the SA values are abnormally low and TW values are abnormally large.[8,9] In Eustachian tube dysfunction cases, whereas the SA, TW, and ECV values are within the normal ranges, the TP*P* values are abnormally negative.[10]

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Previous studies have found that the tympanometric values in participants from different ethnic groups are different.[11-13] This warrants the need of tympanometric normative data for specific ethnic categories for accurate diagnoses of middle ear disorders. In a multiracial Asian country like Malaysia, the population census showed that the majority of residents were natives (mostly Malay) (67.4%) and followed by Chinese (24.6%).[14] As an effort to serve these two ethnic groups, previous studies have determined the tympanometric normative data for Chinese and Malay subjects.[12,15] However, no study has been conducted to directly compare the tympanometric results between these two ethnic categories. Furthermore, the gender effect on tympanometric results remains debatable. While some studies found significant gender effects on SA, ECV, and TW,[13,16] other studies revealed no gender difference in SA and TW parameters.[12,15]

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TPP, on the other hand, was not influenced by either ethnicity or gender.[11-13] This study, therefore, aimed to compare the tympanometric results (SA, ECV, TPP, and TW) between two ethnic groups (Malay versus Chinese) and genders. Consequently, if these demographic factors were found to be significant, specific normative data would be proposed for clinical purposes.

Materials and Methods

Study design

The current study employed a comparative research design. Before the data collection, an ethical approval was obtained from the Institutional Ethics Committee which is in accordance with the 1975 Declaration of Helsinki and its later amendments.

Study participants

Seventy-two young adults (144 ears) with ages ranging from 20 to 25 years (mean age of 22.1 ± 1.3 years) participated in this study. They were recruited randomly among students and staff members of the respective institution. The participants were then assigned into two ethnic groups: Malay (31 participants: 14 males and 17 females) and Chinese (41 participants: 20 males and 21 females). All participants fulfilled the inclusion criteria as they had (1) no reported history of ear, nose and throat diseases, (2) no recent upper respiratory tract infection or medical illness, (3) normal tympanic membrane as revealed by otoscopic examination, (4) normal ipsilateral acoustic reflexes at frequencies of 500, 1000, and 2000 Hz, and (5) pure tone audiometric thresholds of 20 dBHL or better between 250 and 8000 Hz.

Study procedure

All participants provided their informed consent. A tympanometric device, Interacoustic AT235 Middle Ear Analyzer, which was calibrated in accordance with EN 60645-5/ANSI S3.39 (1987), was used for tympanometry and acoustic reflex testing. Pure tone audiometer of Grason-Stadler GSI-61, calibrated according to ANSI S3.6 (1996) was used for pure tone audiometry assessment. They then underwent a standard 226 Hz tympanometry and tympanometric parameters including SAECV, TPP and TW were calculated automatically from tympanograms. The pressure was swept from positive to negative pressure (+200–−400 daPa) with pump speed of 150 daPa/s. All measurements were carried out in the Audiology Clinic, University Hospital.

Statistical analysis

Data were analyzed using descriptive and inferential statistics. Since the data were found to be normally distributed (as shown by Kolmogorov–Smirnov test, $P > 0.05$), parametric analyses could be carried out. A paired *t*-test was then used to compare the tympanometric results between left and right ears. For ethnicity and gender comparisons, a two-way multivariate analysis of variance (MANOVA) was performed. Finally, one sample *t*-test was carried out to compare between the data obtained from this study and the corresponding findings from Wan and Wong.[12] The statistical significance level was set at $P < 0.05$. All data were analyzed using the SPSS software version 20 (SPSS Inc., Chicago, IL, USA).

Results

Descriptive statistics (mean, standard deviation [SD] and 90% range) for the measured SA, ECV, TPP, and TW of all participants are shown in Table 1.

The paired *t*-test revealed no significant differences in all tympanometric parameters between the left and right ears ($P > 0.05$). The left and right data were then pooled for subsequent analyses. The two-way MANOVA with ethnicity and gender as factors was performed to determine the effects of ethnicity and gender on the tympanometric results. The dependent variables were SA, ECV, TPP, and TW values. The analysis then showed that the main effects could be interpreted independently as no interaction effect was found between ethnicity and gender ($F(1,140) = 1.10$, $P = 0.359$). When the two ethnic groups were compared, no significant differences in all tympanometric results were noted ($F(1,140) = 1.25$, $P = 0.295$).

On the contrary, the gender effect was significant ($F(1,140) = 6.21$, $P < 0.001$). Further univariate analyses revealed significant gender differences in SA ($F(1,143) = 10.27$, $P = 0.002$) and ECV ($F(1,143) = 19.70$, $P < 0.001$) values. Specifically, male participants showed higher SA and ECV values than female participants. The middle ear function between males and females were not different statistically in TPP ($F(1,143) = 0.22$, $P = 0.638$) and TW ($F(1,143) = 1.72$, $P = 0.192$) values. The one sample *t*-test revealed no significant differences in all tympanometric parameters (SA, ECV, TPP, and TW) between the Chinese group in the present study and the Chinese participants in the study by Wan and Wong[12] ($P > 0.05$).

Discussion

The present study found no significant differences in all tympanometric parameters between Malay and Chinese participants. On the contrary, Shahnaz and Davies found a significant ethnicity effect on the tympanometric results by comparing Caucasian and Chinese young adults.[11] They concluded that the difference in body size might have contributed to this (i.e., Chinese adults have a smaller body size, especially the size of the middle ear and ear canal than Caucasian adults). Malay and Chinese adults are both from Asia origin, and typically, their body size does not differ much.[17] Therefore, the insignificant differences in tympanometric results between the two ethnic groups found in the current study were sensible. When the data of Chinese participants in the present study were compared with the results of Southern Chinese in the study by Wan and Wong,[12] no significant differences were found in all tympanometric parameters. This suggests that the Chinese participants recruited in both studies have similar anatomical structures of the ear.

Table 1: Mean, standard deviation and 90% range (5th and 95th percentiles) of tympanometric results by ethnicity and gender

Tympanometric parameter	Chinese		Malay	
	Male (*n*=40)	Female (*n*=42)	Male (*n*=28)	Female (*n*=34)
SA (ml)				
Mean±SD	0.52±0.19	0.40±0.17	0.53±0.16	0.47±0.18
90% range	0.21-0.98	0.17-0.76	0.22-0.85	0.22-0.84
ECV (ml)				
Mean±SD	1.25±0.25	1.03±0.21	1.32±0.44	1.12±0.21
90% range	0.90-1.78	0.77-1.45	0.72-2.26	0.82-1.49
TPP (daPa)				
Mean±SD	−15.98±13.57	−20.12±15.37	−21.50±16.63	−18.44±10.78
90% range	−53.35-12.20	−40.25-−6.00	−65.85-−1.80	−39.75-1.50
TW (daPa)				
Mean±SD	80.38±16.38	80.36±22.26	86.96±25.58	76.18±20.00
90% range	45.75-110.00	50.00-135.50	42.25-135.50	47.50-110.00

SD: Standard deviation, SA: Static admittance, ECV: Ear canal volume, TPP: Tympanometric peak pressure, TW: Tympanometric width

Significant effects of gender on SA and ECV values were found in the present study. These findings are in line with the study by Wahab and Rashid that determined the tympanometric normative data among young Malay adults.[15] In the present study, male participants showed slightly higher mean SA, lower (5th percentile) and upper (95th percentile) ends of 90% range than female participants. Higher SA values in males are possibly related to the body size, particularly, the average size of middle ear cavity. In this regard, the larger the middle ear cavity size, the higher the SA value.[16] The gender difference in SA value was also demonstrated in Caucasian adults.[13] In this study, higher ECV values were noted in male participants than in female subjects, which is in accordance with the previous reports.[12-16] Again, the difference in the body size between males and females is likely the reason for this.[11,16] In line with the previous reports, the present study yielded insignificant gender effect on TPP and TW values. TW and TPP were the least affected tympanometric parameters in the standard tympanometry by ethnicity, gender or even by different machines.[11-13,15]

Since the current study found some gender differences in the obtained data, having gender-specific normative data of tympanometric parameters can be advantageous. Table 2 shows the tympanometric normative data (mean, SD and 90% range of SA, ECV, TPP, and TW) derived from the present study in terms of gender (*n* = 144, the data for Malay and Chinese participants were pooled).

Table 2: Tympanometric normative data for Malay and Chinese adults by gender (*n*=144)

Tympanometric parameter	Male (*n*=68)	Female (*n*=76)
SA (ml)		
Mean±SD	0.53±0.18	0.43±0.17
90% range	0.24-0.82	0.22-0.77
ECV (ml)		
Mean±SD	1.28±0.34	1.07±0.21
90% range	0.88-1.93	0.81-1.46
TPP (daPa)		
Mean±SD	−18.25±15.04	−19.37±13.46
90% range	−50.15-−3.35	−36.25-−6.00
TW (daPa)		
Mean±SD	83.09±20.75	78.49±21.24
90% range	48.50-119.75	50.00-110.00

SD: Standard deviation, SA: Static admittance, ECV: Ear canal volume, TPP: Tympanometric peak pressure, TW: Tympanometric width

Conclusions

While no statistical differences in tympanometric results were found between Malay and Chinese groups, the gender effect was observed in SA and ECV parameters of tympanometry. For a more accurate diagnosis of the middle ear status among Malay and Chinese patients with the standard 226 Hz tympanometry, we recommend the use of gender-specific normative data obtained from the present study. Nevertheless, for assessing patients in a global manner, more studies are warranted. Perhaps, future studies should focus on expanding the tympanometric normative data by including different age groups (e.g., middle age, elderly, etc.) and other ethnicity groups (e.g., Northern Chinese, Indian, etc.).

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Conflicts of interest

There are no conflicts of interest.

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