# **Original Research Article**

DOI: http://dx.doi.org/10.18203/issn.2454-5929.ijohns20180716

# Analysis of type of tympanograms across different age groups in a tertiary care hospital: a retrospective study

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**Received:** 29 November 2017 **Accepted:** 29 December 2017

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#### **ABSTRACT**

**Background:** Tympanometry is a non-invasive test clinical test for the assessment of middle ear status/functioning. Several studies over the past few years have produced conflicting results regarding changes in the middle ear function with advancing age. Hence, the present study is aimed to give evidences on distributions of type of tympanograms in males and females under various age groups.

**Methods:** The study followed retrospective design, where data collected from January 2017 to October 2017 were used. A total of 2,292 tympanograms of the 1146 patients were analysed. Descriptive statistics and Wilcoxon's signed rank test were used. A p-value <0.05 was considered as significant.

**Results:** It was documented that higher occurrence of 'B' type and ' $A_d$ ' type of tympanogram in paediatric group and geriatric group respectively. As it is expected, 'A' type of tympanogram is predominant in adult and older adult group. Also, there was no gender difference seen in type of tympanograms.

**Conclusions:** Higher occurrence of 'B' type of tympanogram in paediatric group warrants medical line of treatment and educating on ear-hygiene in them.

Keywords: Type of tympanogram, Tympanometry, Paediatric group, Geriatric group, Gender differences

#### **INTRODUCTION**

Of the types of disability, hearing disability is the second most common disability after visual disability in India. Throughout the world, hearing impairment affects 5.3% people whereas in India, hearing impairment affects 6.3% of the population.<sup>1,2</sup> The estimated prevalence of adult hearing loss was found to be 7.6% and childhood onset deafness to be 2%.<sup>3</sup> Aging or presbycusis is the most common cause of hearing loss (10.3%). Second most common cause is middle ear infections such as chronic suppurative otitis media (5.2%) and other major causes include genetic or congenital hearing loss.<sup>4</sup>

Consequences of hearing impairment include inability to hear and interpret sounds and which often affects an effective communication, delay in speech and language acquisition, educational disadvantage, social isolation and stigmatization.<sup>5,6</sup> Hence, it is crucial to identify hearing loss to eliminate the consequences.

Often hearing impairment is diagnosed using a battery of tests. The battery of test includes pure tone audiometry, immittance audiometry, oto-acoustic emissions, auditory brainstem responses. However, pure tone audiometry is considered to be the 'gold standard test' to diagnose the type and degree of hearing loss. Next test which is routinely followed is immittance audiometry, which consists of tympanometry and reflexometry.

Tympanometry is a non-invasive test clinical test for the assessment of middle ear status/functioning. It gives

information regarding the movement of the tympanic membrane (static admittance), pressure at which the movement of tympanic membrane is maximum (peak pressure), the volume of air between the tympanic membrane and opening of the ear canal (ear canal volume). All these three major parameters give information regarding the status of the middle ear.<sup>7</sup> The classification system described by Liden and Jerger is the most commonly used and categorizes the amount of compliance and static admittance into three types of tympanograms: A, B, and C. 8-10 Type A suggests normal tympanic membrane mobility. It can be further classified into Type ' $A_d$ ' and ' $A_s$ '. Type ' $A_d$ ' represents abnormally high static admittance and Type 'As' represents abnormally low static admittance. Type 'B' represent little or no static admittance while Type 'C' represents normal static admittance, but with negative pressure in the middle ear cavity.

Several studies over the past few years have produced conflicting results regarding changes in the middle ear function with advancing age. Investigators have reported decreased static admittance with age whereas there are other reports with no change in admittance with age. Investigators have conflicting results were seen for tympanometric peak pressure, ear canal volume and pathological conditions. Hence, the present study is aimed to give evidences on distributions of type of tympanograms in males and females under various age groups. The objectives of the study were to describe the most and least prevalent type of tympanograms found in different age groups and to analyze the differences in type of tympanograms obtained in male and female groups.

# **METHODS**

The aim of the study is to describe the type of tympanograms in patients who reported to Mandya Institute of Medical Sciences, Mandya. The effect of age and gender on the type of tympanograms was also examined. To achieve the aim, the following procedure was followed.

# Source of data

The study followed retrospective design, where data collected from January 2017 to October 2017 were used. A total of 2,292 tympanograms of the 1146 patients were analysed, who were reported at Audiology unit, ENT Department. Approval from the Institutional Ethics Committee, Mandya Institute of Medical Sciences was obtained before initiation. The patients were from Mandya district and in the age range of 3 to 75 years. Patients with incomplete demographic details and tympanometric results were excluded from the study.

#### Procedure

For every patient, demographic detail such as age, gender and place followed by a detailed case history were taken. Pure tone audiometry was done by estimation of air conduction and bone conduction thresholds using bracketing method in a sound-treated room using global (Type 2) audiometer.

Otoscopy was done to view the ear canal size, tympanic membrane and cone of light. Otological cases that had active ear discharge and impacted ear wax were asked to re-visit after medical treatment. Interacoustics AT235 automated immittance meter was used. The patients were made to sit in a chair comfortably and were instructed to stay ideal, avoid unnecessary head movements, speaking and swallowing when probe has been inserted. Clean suitable size ear tip was inserted to the straightened ear canal. Once the proper seal is achieved, the testing was performed automatically. The probe tone of 226-Hz was utilised. The direction of pressure change is from positive to negative and it ranges from +300 daPa to -300 daPa. Tympanogram traces were repeated to ensure the reliability and to avoid artifactual results.

Tympanometric measures such as static admittance, tympanometric peak pressure and ear canal volume were documented. Static admittance is the value on vertical axis and tympanometric peak pressure is the quantity on horizontal axis, at which the peak is maximum. Ear canal volume is the volume (cc) measured from the entrance of the ear canal (probe tip placement) to the tympanic membrane. Based on these tympanometric measures, tympanograms were further categorized as 'A', 'As', 'Ad', 'B', 'C' and 'Cs' type of tympanograms using Jerger classification system.<sup>8,9</sup>

The age groups were categorized as paediatric group (1-14 years), adult (15-44 years), older adults (45-64 years) and elderly group (>65 years), as per WHO classification. Most prevalent and least occurring type of tympanograms were analysed across aforementioned age groups and gender.

#### Data analysis

Descriptive statistics were used to define patient demographics and type of tympanograms. Wilcoxon's signed rank test was used to compare the male and female tympanograms irrespective of age groups. The significance level of 0.05 was used.

# **RESULTS**

The study was conducted to analyse the distribution of type of tympanograms in patients who visited tertiary care hospital, Mandya. The data from January 2017 to October 2017 consisted of 1,162 patients, where patients with incomplete demographic and test results (n=16) were omitted. The age of the patients ranged from 3 to 75 years, with the mean age being 48.5 years. A majority of the individuals fell between the age ranges of 41 and 55 years. It was noted that 597 (52.09%) were males and 549 (47.91%) were females. Information regarding to type of

tympanogram were constituted for number of ears. Among the total ears (2292 ears) reviewed, 872 ears (38.05%) found to have normal tympanogram (A type), while other 1420 ears (61.95%) had abnormal

tympanograms; Among 872 ears which had normal tympanograms, 425 were male ears (48.7%) and 447 (51.3%) were female ears. and the results were as depicted in Table 1.

Table 1: Distribution of type of tympanogram across different age groups and gender (M- male F-female).

Age/Type	1-14 yrs (Paediatric group)		15-44 yrs (Adult group)		45-64 yrs (Older adult group)		>65 yrs (Geriatric group)	
	M	F	M	F	M	F	M	F
A	17	15	149	146	148	195	111	91
As	23	22	61	92	162	137	88	79
Ad	02	04	13	10	33	20	122	76
В	28	25	27	20	22	12	6	6
C	11	13	28	17	34	28	28	11
Cs	11	11	12	33	31	28	27	07

Of the total ears tested, paediatric group comprises of 182 ears (7.9%), whereas adult group had 608 ears (26.5%), while the older adult group consisted of 850 ears (37.2%) and finally geriatric group involved 652 ears (28.4%) were tested for tympanometry.

In paediatric group, 'B' type tympanogram (29.2%) was found to be most predominant type followed by 'A<sub>s</sub>' type (24.7%). However, 'A<sub>d</sub>' type (3.3%) was least occurring type of tympanogram. Only 17.5% of paediatric group had 'A' type of tympanogram, which is considered to imply normal middle ear status. On the other hand, in both adult group and older adult group, the second most occurring type of tympanogram was 'A<sub>s</sub>' type (25.1% & 35.1%) after 'A' type (48.5% & 40.3%). Conversely, 'A<sub>d</sub>' type (3.7%) and 'B' type (4%) were less common type of tympanogram seen in adult group and older adult group respectively. However among geriatric group, normal tympanogram (30.9%) and 'A<sub>d</sub>' type (30.3%) were principal type when compared to other type of tympanograms.

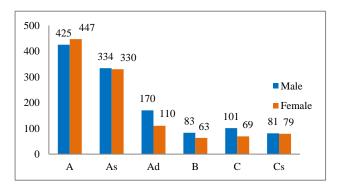


Figure 1: Distribution of type of tympanograms in male and females irrespective of age groups.

#### Gender differences in type of tympanograms

In the current study, the type of tympanograms was compared among males and females irrespective of age groups to find any significant differences. A Wilcoxon signed-rank test showed that no statistically significant change (Z=13.2, p>0.05) in males and females tympanograms.

#### DISCUSSION

In the present study, there were total of 182 ears in the pediatric group. Of the 182 ears, 'B' type was more prominent then followed by 'As' type tympanograms. In children less than 6 years, the incidence of otitis media is around 9.2% in India and hence there is greater occurrence of 'B' type tympanogram in pediatric population. 16,17 In children, growth entails changes in the ear that generate mechanical alterations, which influences the tympanogram findings. <sup>18,19</sup> The mass dominated system grows into stiffness dominated system and eventually gives a 'As' type of tympanogram and this might be the reason for the 'As' type of tympanogram being the next most predominant type after 'B' type. In addition, recurrent episodes of middle ear effusion and otitis media might also change the characteristics of middle ear and as a result in tympanogram changes from 'B' type to 'A<sub>s</sub>' type tympanogram progressively. <sup>7,20,21</sup>

On the other hand, the most frequently occurring type of tympanogram in the adult group and older adult group is 'A' type. This result is well predictable, as the anatomical and physical changes progress in the developing ear from birth to adult and thereby the static admittance value improves with age.<sup>7</sup>

However, subtle changes in hearing apparatus begin from age 40s and progress gradually with age. The second most prevalent type is the Jerger's type 'A<sub>s</sub>' tympanogram, providing an evidence of increased stiffness (reduced compliance) of the conducting mechanisms. Among older adult group, next frequent type of tympanogram is 'C' which suggests Eustachian tube dysfunction and this could be attributed to the development of negative middle ear pressure in middle ear cavity due to muscle weakening of Eustachian tube.<sup>22</sup>

In geriatric population, ' $A_d$ ' is the most frequent type of tympanogram as the tympanic membrane is thin and more compliant with advancement in age.<sup>22</sup> There is evidence that, the human tympanic membrane exhibits a loss of vascularization, a reduction in collagen structure, in elasticity, and greater rigidity in the middle fibrous layer with advancing age.<sup>23</sup> These structural changes would be expected to alter the compliance response of the middle ear.

Later, in the present study there was no gender differences seen between the type of tympanograms obtained irrespective of age groups. This is in accordance with the study conducted by Gates et al and Sogebi. 24,25 On contrary, gender differences were seen as higher ear canal volume in males when compared to females. 7,26 But in the current study, only compliance measure was taken into consideration while categorizing into Jerger's type of tympanograms classification.

#### **CONCLUSION**

A retrospective analysis of type of tympanograms was carried out. It was documented that higher occurrence of 'B' type and ' $A_d$ ' type of tympanogram in paediatric group and geriatric group respectively. As it is expected, 'A' type of tympanogram is predominant in adult and older adult group. The present study demands medical line of treatment and awareness on ear-hygiene especially in paediatric group.

# Limitations

This is a hospital-based study and therefore may not represent entire population. Tympanometer which was used was automated and hence parameters could not be varied. Despite these limitations, the study was able to demonstrate the most predominant type of tympanograms across age groups in Mandya population.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee of Mandya Institute of Medical Sciences

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Cite this article as: Hanumantha PM, Ravi D, Balaji NK, Sowmya TR, Puttaraju S, Jagadish N. Analysis of type of tympanograms across different age groups in a tertiary care hospital: a retrospective study. Int J Otorhinolaryngol Head Neck Surg 2018;4:512-6.