ORIGINAL ARTICLE DOI:https://doi.org/10.52206/jsmc.2023.13.2.772 OPEN ACCESS

The Hearing Impaired Child- Pattern of Tympanograms in Otitis Media with Effusion.

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ABSTRACT

Background: Otitis media with effusion (OME) is a common cause of treatable hearing loss in children. Tympanometry is an objective tool for assessment of this condition. Of the various tympanometric curves, Type B flat curve is commonly associated with OME. The study aims to determine the various curves associated with OME and find the commonest one.

Objective: To determine the frequency of various types of curves obtained on tympanogram in children suffering from otitis media with effusion.

Material and Methods: This descriptive cross sectional study involving 350 ears with OME was conducted in ENT Department of Medical Teaching Institution, Hayatabad Medical Complex, Peshawar. Non-probability convenience sampling technique was used to select children with OME.History, Clinical examination, otoscopy, audiometry and tympanometry were used to diagnose OME. Tympanometry was performed to determine the type of curves using Jerger classification. The frequency of the various types of curves obtained was calculated.

Results: The age range of the patient was 3-15 years with mean age of 8.25±3.22 years. The male: female ratio was of 1.22:1. Type B curves were the commonest inall age groups. The overall frequency for Type B curve in the study was 81.4%. Chi square test showed that Type B tympanogram significantly occurred in the lower age groups ranging from 3 to 11 years.

Conclusion: Type B tympanogram is the commonest type of curve in children suffering from otitis media with effusion. It is significantly associated with OME in the younger age groups as compared to Type C & Type A. Therefore it can be used for in the diagnosis and follow-up of younger children with OME.

Keywords: Audiometry, Glue, Otitis Media with Effusion, Paediatrics, Tympanometry.

This article may be cited as: Muhammad AY, Anwar K, Khan S. The Hearing Impaired Child- Pattern of Tympanograms in Otitis Media with Effusion. J Saidu Med Coll Swat 2023;13(2):34-39.

INTRODUCTION

Otitis media with effusion (OME) refers to collection of sterile exudates behind the intact tympanic membrane. The accumulated fluid may be serous or mucoid and can be as extensive as to occupy the whole of middle ear cleft and mastoid air cells system. Hearing impairment is a common cause of preventable deafness and, if untreated, can lead to delayed speech acquisition, poor performance at school and behavioral abnormalities.[1]

OME most commonly affects children 1-7 years old. In the under 5 years group OME has a point prevalence of 20% and a period prevalence of 80%. Approximately 80% of all children will have had a single episode of OME before the age of 3 years and 40% will have three or more episodes.[2,3]

As otitis media with effusion is a treatable cause of hearing deficit, therefore, close observation is necessary. Diagnosis of the condition is relatively simple and does not require sophisticated gadgets. Pneumatic otoscopy, tympanometry, loss of stapedial reflex, pure tone audiography together with clinical suspicion of hearing impairment are sufficient to diagnose this condition. Tympanometry is an objective, non-invasive, painless test and does not rely on patients' responses. It is, therefore, a very reliable tool in the assessment of OME. Type B tympanogram with flat curve and normal canal volume is the commonest curve obtained & considered diagnostic of otitis media with effusion. As compared to all other types of curves obtained on tympanogram, it has a sensitivity and specificity of 84 (95% CI 82-86) and 79 (95% CI 76-83) respectively.[4] The Type C curve is useful when correlated with other clinical findings but by itself is an imprecise estimate of middle ear pressure and has a low sensitivity and specificity for detection of middle ear disorders.[5]

The study aims to determine the frequency of various types of tympanometric curves in association with otitis media with effusion and impress upon the importance of tympanometry as a diagnostic tool in diagnosis of middle ear effusion. The change of one form of curve to another is meaningful and understanding of this fact will help the clinicians in management of children with OME.

MATERIAL AND METHODS

This descriptive and cross sectional study was conducted in ENT Department of Medical

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Received: January 13th, 2023 Accepted: March 23th, 2023

Teaching Institution, Hayatabad Medical complex, Peshawar during the period Oct 1, 2021 to Sep 30, 2022. The samples were collected using non-probability convenient sampling technique. The study included 350 ears in 200 patients fulfilling the inclusion criteria. The sample size was calculated using Calculator.net software for sample size determination. It was calculated assuming 20% proportion for OME in children[6] with 95% confidence interval and a margin of error of 5%.

Children aging 3 to 15 years complaining of hearing loss, otoscopic evidence of OME were included in the study. Children with congenital or familial hearing loss, acute and chronic suppurative otitis media, or those who received radiotherapy to the head & neck.

Patients were included in the study after taking informed consent from parents and IREB approval vide letter No 1116. All the hearing impaired children visiting ENT ward, outpatient department and institutional based private practice were included in the study. Detailed history was obtained from parents regarding respiratory tract infections, earache, nasal obstruction, nasal discharge, sleep disturbances, inattention at home and school, delayed speech, sore throats and hoarseness of voice. Clinical ENT examination was carried out. Speech defects, Down's syndrome & congenital anomalies were looked for by assessing the child's speech, syndromic features and ear & palate anatomy. Any wax in the canal was removed to obtain a clear view of the canal and tympanic membrane. Otoscopy was carried out to look for the status of tympanic membrane noting its color, cone of light, retraction pockets and presence of bubbles in middle ear. Pneumatic otoscopy was carried out with Siegel's speculum (Reister) to determine the mobility of tympanic membranes. Conversational voice test was carried with examiner's lips covered at a distance of 6 feet. Tuning fork tests (using 512 Hz pure tone) including Rinne & Weber tests were carried out where appropriate. Both air (AC) and bone conduction (BC) were tested separately on each ear. AC>BC was designated Rinnie + and represented normal or sensorineural hearing loss (SNHL). BC>AC represented conductive deafness in the ear. Weber test was performed by placing the 512 Hz vibrating tuning fork over midline of forehead or root of nose. It lateralized to the conductively deafer ear or normal ear in case the test east ear had SNHL. Those with clinical suspicion of hearing loss were advised pure tone audiometry and or detection of stapedial reflex. Pure tone audiometry(PTA) was carried out using Labat AUDIOLAB Audiometer Model SN AUL 16127.A loss >20 dB at the speech frequencies 500, 1000, 2000 and 4000 Hz in the air conduction on pure tone audiometry was considered suggestive of OME. Children were presumed to have otitis media with effusion if there was loss of 20-40 dB over the speech frequency range. In younger children in whom Pure tone audiometry was not reliable, stapedial reflex was tested with a probe tone frequency of 226 Hz delivered at 100 dB using FLUTE inventis MIDDLE EAR ANALYZER Tympanometer Model R04. The absence of stapedial reflex was considered as evidence for the presence of middle ear effusion. Tympanometry was carried outin those suspected of having middle ear effusions with SIEMENS hand held TP 10 tympanometer using a probe tone frequency of 226 Hz. The types of curves obtained on tympanograms wereclassified using Jerger classification (Jerger 1970) and their type documented. The frequency of various types of curves thus obtained was analyzed and their percentages calculated.

Statistical Analysis:

The information obtained was recorded on a proforma. The percentages of various curves obtained on tympanometry were determined. Descriptive statistics for variables like gender, age were analyzed to determine the frequencies. Cross tables were used to find out the observed relationships of gender and ages of the patient with the curves obtained. Chi square test was performed to determine the significance of types of tympanograms in relation to various age groups and genders. The data was analyzed using IBM SPSS version 26.0 for statistical analysis.

RESULTS

The age range of the patient was 3-15 years with mean age of 8.25 ± 3.22 years. The male: female ratio was of 1.22:1. The age group 6-8 years was the largest group in the study with 103 (29.43%) of the patients. The details of gender and age groupings are given in Table 01. Type B curve was the most frequent curve obtained on tympanometry. Table 02 depicts the details of various types of curves obtained on tympanometry in the study population. Type B curves were most commonly seen in the age group 6-8 years in 87 (24.85%) of patients as compared to the other age groups. The types of

curves obtained in relation to various age groups are shown in Table 03. With respect to gender, Type B curves were most commonly seen in males 153 (43.71%) as compared to 118 (33.71%) of the females. The details of various types of curves obtained in relation to males and female gender are given in Table 04. Type B tympanogram was obtained in 271 (77.4%) of the patients. Chi-square test and p-value determination shows that as compared to other types, the occurrence of Type B tympanogram for the detection of presence of fluid in the middle ear was significant in the age groups 3-5 years, 6-8 years and 9-11 years with their respective p-values at p = .02, p = .04 and p = .02. However at age group 12-15 years the p-value of Type B tympanogram for diagnosis of fluid in the middle ear showed it to be non-significant (p= .06). The association of various age groups & Type B tympanogram is shown in Table 05.

Table 01: The Gender & Age Group Distribution of Participants (n=350)

Age Groups	Gender of Children		Total
	Male	Female	
3-5 Years	53(15.14%)	37(10.57%)	90(25.71%)
6-8 Years	60(17.14%)	43(12.29%)	103(29.43%)
9-11 Years	44(12.57%)	45(12.86%)	89(25.43%)
12-15 Years	35(10.00%)	33(09.43%)	68(19.43%)
Total	**192(54.86%)**	**158(45.14%)**	**350(100%)**

Table 02: The Frequency of Various Types of Tympanograms (n=350)

Tympanogram	Frequency	Percent
Type A	14	4.0%
Type B	271	77.4%
Type C	65	18.6%
Total	**350**	**100%**

Table 03: The Association of Age & Type of Tympanogram (n=350)

Age Groups	Type of Tympanogram			Total
	Type A	Type B	Type C	
3-5 Years	2(0.57%)	72(20.57%)	16(4.57%)	90(25.7%)
6-8 Years	2(0.57%)	87(24.86%)	14(4%)	103(29.43%)
9-11 Years	4(1.14%)	70(20.0%)	15(4.29%)	89(25.43%)
12-15 Years	6(1.71%)	42(12.0%)	20(5.71%)	68(19.43%)
Total	**14(4%)**	**271(77.4%)**	**65(18.57%)**	**350(100%)**

Table 04: The Association of Gender & Type of Tympanogram (n=350)

Gender of Children	Type of Tympanogram			Total
	Type A	Type B	Type C	
Male	4(1.14%)	153(43.71%)	35(10%)	192(%)
Female	10(2.86%)	118(33.71%)	30(22.86%)	158(%)
Total	**14(4%)**	**271(77.4%)**	**65(18.57%)**	**350(100%)**

Table 05: The Association of Age Groups & Type B Tympanogram

Age Groups	Type B	P-Value
3-5 Years	72(20.57%)	.02
6-8 Years	87(24.86%)	.04
9-11 Years	70(20%)	.02
12-15 Years	42(12%)	.06

DISCUSSION

Otitis media with effusion (OME) is a common cause of treatable hearing impairment in the pre-school and school age. It calls for urgent treatment because of its association with adverse effects on the child's speech and learning.[7] The pathophysiology of otitis media with effusion is much varied but the diagnosis is relatively simple. Tympanometry is an objective, simple and non-invasive technique for the diagnosis of middle ear effusion and is widely available. Though not a single curve is diagnostic of OME, in the literature the Type B flat tympanogram with normal canal volume has shown promising results for the presence of middle ear effusion when confirmed on tympanocentesis or myringotomy.[8,9,10]

In our study, Type B curve was the most frequentcurveobtained on tympanometry and was obtained in 271(77.4%) patients. It was most commonly seen in the age group 6-8 years in 87 (24.85%) of patients as compared to the other age groups. These findings conform to those reported in the literature. As reported in the literature, Type B tympanogram has a reported sensitivity of 73-88% and a high specificity of up to 82-98% in detecting middle ear effusion.[4,8,9,10]

In 2016, a study conducted by Anwar K and colleagues at the same center recorded a Type B curve in 71.4% of the 117 ears suspected of OME. The findings obtained on tympanometry were compared with myringotomy findings. The Type B tympanogram showed a sensitivity, specificity, positive predictive value and negative predictive value of 85.85%, 72.22%, 94.44%, 48.14% respectively. The overall accuracy of the Type B tympanogram was recorded at 83.76%.[11] In one other similar study, Pichichero ME while assessing the diagnostic accuracy in otitis media with effusion found that tympanometry was the most useful of all tests. He recorded a Type B curve in 43% of cases of otitis media with effusion and a Type C result in 47% of cases.[12] Cai T & colleagues in their study concluded that a flat tympanogram is diagnostic of middle ear effusion.[13]

Though Type B tympanogram is the norm in tympanometry carried out for otitis media with effusion, Type C and Type A have also been reported in some study populations. Bhatta R and colleagues in Nepal conducted a retrospective analysis of childrenunder12years who underwent myringotomy for otitis media with effusion. The analysis of their tympanograms revealed Type B in 90%, Type C in 4% and Type A in 6 %. They concluded that a Type B curve was a more reliable curve of middle ear effusion.[14,15] In a study by Al-Salem S et al found that effusion volume in the middle ear cavity affected the shape of the tympanometric curve. However they were not able to measure the effect of viscosity and purulence of effusion as all their patients had mucoid and non-purulent effusions.[16]

Darraj E and colleagues while studying 139 children with mean age of 5.2 years (SD= 2.1) found type B tympanogram in 113(82.5%) of patients and fluid on myringotomy in 111(79.9%) of patients. They found the sensitivity and specificity for type B tympanogram respectively at 88.2% and 80.7%. Staistically the result was significant (p>0.05). The concluded that type B curve was highly suggestive for the presence of middle ear effusion.[4]

Caution should be exercised while performing tympanometry in young infants for the curves may be misleading due to distortion. Though the conventional low frequency 226 Hz tone probe has been reported to be an accurate estimate of middle ear effusion, several studies have reported it to be inaccurate in infants younger than 7 months. They recommend the use of a 1000 Hz probe in this age group. In India and colleagues examined 399 ears of 209 infants referred for hearing assessment. Using a 1000 Hz probe frequency were able to obtain the normal Type A, B and C curves.[17,18]

The occurrence of 65 (18.6%) cases of Type C tympanogram in our study is perhaps due to our reliance on pure tone audiometry and absence of stapedial reflexes in selection of patients with hearing loss. results similar to otitis media with effusion may be obtained in patients having negative middle ear pressure due to eustachian tube dysfunction. In contrast the 14 (4%) of the occurrence of Type A tympanograms may well be explained by probe obstruction by debris and a lax canal skin or incomplete seal formation due to ill-fitting probe.

Advantages of the study:

The results of this study show that tympanometry is a useful technique for diagnosing otitis media with effusion. It is a cost-effective, non-invasive and easy to perform technique. The Type B tympanogram has a high sensitivity for detecting middle ear effusion and can be used to follow up children with otitis media with effusion.

Limitations of the study:

Besides the sample size being small, errors can occur if the system is not properly calibrated or lack of proper maintenance leading to obstruction of the ear probe. Moreover work is needed to compare the results of tympanometry with myringotomy which is the gold standard for confirmation of middle ear effusion to determine its accuracy in detecting middle ear effusion.

CONCLUSION

Type B tympanogram is the commonest type of curve in children suffering from otitis media with effusion. It is significantly associated with OME in the younger age groups as compared to Type C & Type A. Tympanometry being a non-invasive & objective technique and is used for screening children suspected of having otitis media with effusion; the Type B curve is a more reliable indicator for diagnosis and follow-up of patients with OME.

Conflict of interest:

We, the authors, have no conflicts of interest to declare in relation to this study.

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DATA SHARING STATEMENT: The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

CONFLICT OF INTEREST: Authors declared no conflict of interest.
GRANTED SUPPORT AND FINANCIAL DISCLOSURE: Nil

AUTHOR'S CONTRIBUTION
The following authors full fill authorship criteria as per ICMJE guidelines;

Muhammad AY:	Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Anwar K:	Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.
Khan S:	Analysis and interpretation of data, drafting the manuscript, critical revision, final approval, agreed to be accountable for all the work.