

Diagnostic Accuracy of Tympanometry for Diagnosis of Fluid the Middle Ears of Children with Otitis Media with Effusion taking Myringotomy as Gold Standard

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ABSTRACT

Objective: To determine the diagnostic accuracy of tympanometry for diagnosing fluid in the middle ears of children with Otitis Media with Effusion taking myringotomy as a gold standard.

Study Design: Cross-sectional study

Place and Duration of Study: Department of ENT & Head and Neck Surgery, Combined Military Hospital, Peshawar Pakistan, from Oct 2018 to Sep 2020.

Methodology: A total of 201 patients who underwent tympanometry followed by myringotomy of aged between 3 to 12 years of either gender were included. All patients underwent tympanometry. After that, myringotomy was carried out through a radial incision in the anteroinferior quadrant using a general inhalational anaesthetic agent. The operative findings at myringotomy were recorded. The presence of fluid on intraoperative findings using myringotomy was considered positive for the presence of fluid in the middle ears of children.

Results: The age range of the patients was from 3-12 years, with a mean age of 7.35 ± 2.41 years. Of these 207 patients, 133(64.18%) were males, and 74(35.82%) were females. The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of tympanometry for diagnosis of fluid in the middle ears of children with Otitis Media with Effusion taking myringotomy as the gold standard was 85.7%, 86.3%, 89.4%, 81.7% and 85.9% respectively.

Conclusion: This study concluded that the diagnostic accuracy of tympanometry for the diagnosis of fluid in the middle ears of children with Otitis Media with Effusion is quite high.

Keywords: Accuracy, Hearing impairment, Otitis media with effusion, Tympanometry.

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INTRODUCTION

Otitis media (OM) is one of the most common reasons for visits to the doctor, antibiotic prescriptions, and surgery.¹ Its complications and consequences are major sources of avoidable hearing loss, especially in developing nations.² Otitis media with effusion (OME) is a condition in which there is fluid in the middle ear and, in certain cases, the mastoid air cell system, but no signs or symptoms of ear infection.^{3,4} Hearing loss or auditory fullness are the most common symptoms. The condition is considered chronic when fluid collection lasts more than 12 weeks.⁵ Its prevalence is bimodal, with the first and largest peak of approximately 20% at two years of age and a second peak of approximately 16% at around five years of age. It is also, around twice as many children diagnosed with OME in the winter as opposed to the summer.⁶ Untreated OME can result in hearing loss and delays

in speech and cognitive development, particularly in young children.⁶ Various tools other than otoscopy have been proposed to diagnose OME to improve diagnostic accuracy, including micro-otoscopy, tympanometry, pneumatic otoscopy, and myringotomy.⁷ Tympanometry can be used to determine the presence of fluid in the middle ear, the mobility of the middle ear system, and the volume of the ear canal.^{8,9}

Despite the limitations of the basic techniques, otitis media with effusion requires high diagnostic accuracy. Acute complications or extended episodes of otitis media with effusion, protracted periods of hearing impairment, and impact on cognitive and linguistic development may result from low diagnostic sensitivity and the neglect of effective treatment.¹⁰ Furthermore, the terrifying result of inappropriate antibiotic treatment is the bacteria's growing drug resistance. Therefore this study was planned to determine the diagnostic accuracy of tympanometry for the diagnosis of fluid in the middle ears of children taking myringotomy as the gold standard.

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METHODOLOGY

After taking the approval of the study from IRBD (87/trg/21), the cross-sectional study was carried out, from October 2018 to September 2020, at the Department of ENT & Head and Neck Surgery, Combined Military Hospital, Peshawar Pakistan. The sample size was calculated taking 16%,⁵ proportion of Otitis media with effusion, using World Health Organization software for sample size determination.

Inclusion Criteria: Patients of either gender, age ranging from 3 to 12 years, underwent tympanometry followed by myringotomy with clinical evidence of otitis media with effusion (abnormal colouration and retraction of the tympanic membrane, air bubbles or fluid level in the middle ear cavity on otoscope) and pure tone audiometry showing conductive hearing loss with A-B gap of >30dB in better ear at the first visit were included in the study.

Exclusion Criteria: Ears with otoscopic evidence of tympanosclerosis, patients with frankly discharging ears or having evidence of cholesteatoma were excluded from the study.

After taking consent, two hundred and seven patients suspected of OME meeting the eligibility criteria were enrolled via a non-probability consecutive sampling technique. All patients underwent tympanometry. The tympanogram was obtained using a 226Hz probe tone. Normal ear canal volume was taken as 0.3–1mL, and the curve was considered flat when it had no discernible peak over a pressure range of +200daPa to -400daPa. Type-B tympanogram with flat curve and normal canal volume alone was taken positively for the presence of fluid in the middle ears of children.

After that, myringotomy was carried out through a radial incision in the anteroinferior quadrant using a general inhalational anaesthetic agent. The operative findings at myringotomy were recorded. The presence of fluid on intraoperative findings using myringotomy was considered positive for the presence of fluid in the middle ears of children.

IBM-(SPSS) version 22.0 was used for data analysis. Mean± standard deviation were calculated for quantitative variables. For qualitative variables like gender frequency(%) were used. Sensitivity, specificity, Positive predictive value, Negative predictive value and diagnostic accuracy for tympanometry against myringotomy were calculated using a 2x2 contingency Table.

RESULTS

Of these 207 patients, 133(64.18%) were males, and 74(35.82%) were females, with age ranging between 3-12 years and a mean age of 7.35±2.41 years. The mean duration of the disease was 4.97±2.04 days, shown in Table-I.

Table-I: Basic Demographics of the Patient (n=207)

Demographics	n(%)
Age (Years)	
3-7	106(51.24%)
8-12	101(48.76%)
(Mean±SD)	7.35±2.41
Duration of Disease	
≤5 days	117(56.72%)
>5 days	90(43.28%)
(Mean±SD)	4.97±2.04 days
Gender	
Male	133(64.42%)
Female	74(35.74%)

In Tympanometry positive patients, 102 (True Positive) had fluid in otitis media with effusion, and 12 (False Positive) had no fluid in otitis media with effusion on Myringotomy. Among, Tympanometry negative patients, 17 (False Negative) had fluid in otitis media with effusion on Myringotomy, whereas 76 (True Negative) had no fluid in otitis media with effusion on Myringotomy, as shown in Table-II.

Table-II: Diagnostic Accuracy of Tympanometry for Diagnosis of Fluid in the Middle Ears of Children with Otitis Media with Effusion taking Myringotomy as Gold Standard (n=207)

	Positive Result on Myringotomy	Negative Result on Myringotomy
Positive on tympanometry	102(TP)*	12(FP)***
Negative on tympanometry	17(FN)**	76(TN)****

*-TP=True positive **-FP=False positive ***-FN=False negative ****-TN=True negative

The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of tympanometry for diagnosis of fluid in the middle ears of children with Otitis Media with Effusion taking myringotomy as the gold standard was 85.7%, 86.3%, 89.4%, 81.7% and 85.9% respectively.

DISCUSSION

The US Clinical Practice Guideline on OME strongly advised doctors to employ pneumatic otoscopy as the primary diagnostic approach, with tym-

panometry as an alternative for confirmation and documentation of effusion duration.^{4,11}

Table-III: Diagnostic parameters of Tympanometry for Diagnosis of Fluid in the Middle Ears of Children with Otitis Media with Effusion taking Myringotomy as Gold Standard (n=207)

Diagnostic Parameters	Values
Sensitivity=True Positive/(True Positive+False Negative)	85.7%
Specificity=True Negative/(True Negative+False Positive)	86.3%
Positive Predictive Value=True Positive/(True Positive+False Positive)	89.4%
Negative Predictive Value=True Negative/(True Negative+False Negative)	81.7%
Diagnostic Accuracy=(True Positive+True Negative)/All Patients	85.9%

Tympanometry is the electroacoustic measurement of the tympanic membrane's impedance. Compared to myringotomy results without overpressure ventilation, tympanometry shows high sensitivity and specificity in identifying middle ear effusion in young children.¹² In Finnish vaccine research, effusion in the middle ear with a flat tympanogram had a positive predictive value of 0.93. In contrast, a normal tympanogram had a negative predictive value of 0.94.¹³ In addition, a type B tympanogram had roughly the same positive predictive value in several investigations.^{14,15} Despite these high numbers, tympanometry is rarely used in general practice.

In a study by Khmmas *et al.* It has been found that the sensitivity, specificity and accuracy of tympanometry were 89%, 63% and 83%, respectively, in detecting fluid in the middle ears of children.⁵ In another study by Anwar *et al.* It has been revealed that the sensitivity of tympanometry was 85.85%, specificity 72.22% and accuracy was 83.76%, respectively, in detecting fluid in the middle ears of children.⁸ The findings are almost identical to those of our study, which found that tympanometry had a sensitivity, specificity, and diagnostic accuracy of 85.7%, 86.3% and 85.9% for diagnosing fluid in the middle ears of children with Otitis Media with Effusion using myringotomy as the gold standard.

Finitzo *et al.* observed that the sensitivity was (93%) and specificity was (58%) with a positive predictive value of 92 percent in their investigation. There was an 8% rate of false positives.¹⁶ In our research, we found 12 cases of false positives. One probable explanation is that inhalational anaesthetics can aerate the middle ear, resulting in a 'false' dry tap.¹⁷ A similar study from Iraq, found an accuracy of

71.4%, a sensitivity of 97.3%, a specificity of 57.2%, a positive predictive value of 55.3%, and a negative predictive value of 97.5% when using fluid tap at myringotomy as the gold standard and the type-B tympanogram with the flat curve as an indicator of OME. In 62% of these patients, the Type-B flat curve was obtained.¹⁸

CONCLUSION

This study found that tympanometry had good diagnostic accuracy for detecting fluid in the middle ears of children with Otitis Media with Effusion. As a result, it is advised that tympanometry be performed frequently in all cases of otitis media with effusion in order to make effective care decisions and, as a result, reduce the morbidity of these patients.

Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SAAM & SNR: Conception, study design, drafting the manuscript, approval of the final version to be published.

ZH & AAK: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

MM & MNK: Critical review, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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