Statistical Analysis of Tympanometry, Otoendoscopy and Myringotomy of Pediatrics Otitis Media with Effusion

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ABSTRACT:

BACKGROUND:

Otitis media with effusion (OME) is a common treatable cause of hearing impairment in children. Although it is a self-limiting condition in the majority of cases, OME may become chronic to the extent that it affects child education and quality of life. Thus, early detection of this condition is a paramount issue for its treatment and improve the hearing of the effected child.

OBJECTIVE:

This study is aimed to evaluate the efficiency of tympanometry in the detection of fluid in the middle ear in comparison with myringotomy in children with OME as well as to evaluate the efficiency of otoendoscopy and to analyze the clinical data and predisposing factors for OME.

PATIENTS AND METHODS:

A total of 80 patients (160 ears) of children, with clinical features indicating OME were enrolled in this prospective study during the period from April 2018 to the end of March 2019. Patients were subjected to clinical assessment, and the middle ear examined with otoendoscopy and with tympanometry. The presence or absence of OME was confirmed by myringotomy. The sensitivity, specificity of otoendoscopy, and tympanometry were calculated.

RESULTS:

The fluid was aspirated from the middle ear during myringotomy from 114 ears (71.15%) and the aspirate was serous in 54 ears (47.37%), mucoid in 60 ears (52.63%). Type B tympanometry was recorded in 108 ears with the rest 6 ears had other types of tympanometry (A or C). Thus, the sensitivity, specificity, and accuracy of tympanometry were 94.74%, 65.22%, and 86.25%, respectively. On the other hand, 98 ears with OME were detected depending on the changes in the middle ear observed by otoendoscopy. Therefore, the sensitivity, specificity, and accuracy of otoendoscopy were 85.96%, 60.87%, and 62.5% respectively.

CONCLUSION:

Both tympanometry and otoendoscopy, in general, have a high sensitivity and low specificity in the detection of OME, with the priority to tympanometry over otoendoscopy. Therefore, the definitive diagnosis of OME should be confirmed during myringotomy, and examined by tympanometry to identify the type of curve result and to assess the middle ear pressure.

KEYWORDS: otitis media, myringotomy, ootoendoscopy

INTRODUCTION:

Otitis Media with Effusion (OME), also known as "Glue Ear" or "Secretory Otitis Media", is an inflammatory condition of the middle ear cleft, acute or chronic, with a collection of non-purulent fluid behind an intact TM [(1)]. It is the most frequent cause of conductive hearing loss in childhood [(1)]. Approximately 2.2 million new cases of OME are diagnosed annually in the United States, with 50% to 90% of children affected by 5 years of age, and the prevalence is about 7 to 13% [(2)]. Otitis media is a common reason for outpatient visits to pediatricians, accounting for 1 in 9 (11.4%) office encounters in primary care practices [(3)]. Of these otitis media visits, about 1 in 3 are for OME, which can present as the primary diagnosis (17%), in conjunction with AOM (6.5%), or under the general heading of nonspecific otitis media (13%) [(1-3)]. There are two hypotheses have been postulated for the pathology of OME, the inflammatory hypothesis [(4, 5)], and the gastro-esophageal reflux and allergy hypothesis [(6, 7)].

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Most cases of OME are diagnosed clinically following an otoscopic examination[8].

Tympanocentesis can serve as both a therapeutic procedure and a diagnostic procedure. A pneumatic otoscope with a rubber suction bulb and a tube is used to assess the mobility of the TM [9].

Pneumatic otoscopy combined with tympanometry improves the accuracy of diagnosis because many abnormalities of the eardrum and ear canal cause an abnormal tracing can be visualized [10].

Tympanometry is particularly useful in child intolerance of pneumatic otoscopy, inability to reliably perform pneumatic otoscopy, difficulty visualizing the TM, uncertainty about the presence or absence of OME, need or desire to rule out OME in an at-risk child, and need or desire for objective confirmation of OME before surgery [11].

The management of OME can be divided into conservative, medical, and surgical management including Adenoidectomy, and myringotomy [12, 13]. Myringotomy is the incision and drainage procedure for AOM [16]. Otoendoscopy is a product of technology that allows the illumination of the tympanic membrane, with or without magnification [14-20].

AIMS OF THE STUDY:

The study is aimed to evaluate the efficiency of type B curve in the detection of fluid in the middle ear in comparison with myringotomies findings in children with suspected OME as well as to evaluate the efficiency of otoendoscopy and to analyze the clinical data and predisposing factors for OME.

PATIENTS AND METHODS:

Study design and settings

A prospective study was conducted in the Department of ENT and Head and Neck Surgery at Al-Imamain Al-Kadhumain Medical City at the period from 1st April 2018 to 30th of March, 2019. The study enrolled 160 ears (80 patients) with tympanometric evidence of OME undergoing myringotomies during this period.

Inclusion Criteria

1. Children between the age of ٥-12 years from both genders.
2. All patients undergoing tympanometry followed by myringotomies and adenoidectomy.
3. Patients with types A, B, and C tympanograms with clinical evidence of OME.
4. Pure tone audiometry showing conductive hearing loss with an air-bone gap of >30 dB in better ear at the first visit.
5. Type B tympanogram with normal canal volume.

Exclusion Criteria

1. Ears with otoscopic evidence of tympanosclerosis.
2. OME persisting for less than 3 months.

Ethical Considerations

The permission to undertake this study was sought from Al-Imamain Al-Kadhumain Medical City Scientific and Ethics Committee.

Informed consent

Informed consent was obtained from the child's parents after explaining to them the objective of the study.

Data collections

This included demographic data, history of chronic nasal obstruction, snoring, and/or mouth breathing, and/or obstructive breathing during sleep and/or sleep disturbance. History of hearing loss (duration and mode of onset, a progression of symptoms, and performance at school) and otalgia. History of nasal allergies, recurrent episodes of upper respiratory tract infections, cleft palate repair, gastroesophageal efflux, and concomitant systemic disorders.

Physical Examination

The otological examination involved assessing for any abnormality or disease in the external auditory canal and the middle ear. Accordingly, body temperature should be measured through oral, or axillary methods. In addition to a carefully documented examination of the external ear and TM, examining the entire head and neck region of patients was performed.

Otoscopy and Tuning Fork

The tympanic membrane color, translucency, position, cone of light, presence of air bubble, or a fluid level were assessed. Tuning fork examination at 512Hz was done on all patients. Pneumatic otoscopy provides a dynamic assessment of TM and middle ear.

Pure tone audiometry

Pure Tone Audiometry (PTA) was performed using frequency range from (250 Hz to 8000 Hz) and intensity level from (-10 dB to 120 dB) both air conduction and bone conduction study were achieved.

Tympanometry

Tympanometry was performed in a quiet room using a middle ear analyzer (TympStar, GSI, Eden Prairie, MN), with a continuous probe signal of 85 dB SPL at 226 Hz frequency and a sweep rate of 50 daPa/s. Recordings included the equivalent ear canal volume, peak compensated static acoustic admittance, tympanometric gradient, and tympanometric peak pressure. Patients with all types of tympanograms were subjected to myringotomy.

Myringotomy

All myringotomies were carried out through a radial incision in the anteroinferior quadrant using a general inhalational anesthetic agent. The operative findings at myringotomy were recorded.

Statistical Analysis

The data and the descriptive statistics were analyzed using SPSS 16 for Windows to determined frequencies for variables. The accuracy, sensitivity, and specificity were calculated.

RESULTS:

Demographic characteristics and duration of OME

The most affected age group was 5-7 years accounting for 56.25% of the total patients followed by age group 8-10 (30%), while the least affected age group was the child (11-12 years) accounting for only 13.75%. Males were slightly higher than females (57.5% versus 42.5%), with M:F ratio of 1.35:1. Duration of illness ranged from 3 months to 2 years; however, about half of the patients (47.5%) had a duration of 6-12 months. Although not all cases are predisposed by certain conditions, five predisposing factors were recorded in this study with passive smoking was the most prevalent responsible for one-fifth of the cases followed by food allergy (12.25%), as showed in table 1.

Table 1: Demographic Characteristics and Duration of OME

		No.	%
Age group (years)	5-7	45	56.25
	8-10	24	30
	11-12	11	13.75
Gender	Male	46	57.5
	Female	34	42.5
Duration	3-6 months	32	40
	6-12 months	38	47.5
	> 1 year	10	12.5
Predisposing factors	Passive smoking	16	20
	Food allergy	13	16.25
	Bottle feeding	11	13.75
	Use of pacifier	6	7.5
	Gastroesophageal efflux	4	5

Presenting symptoms

Children were presented with different complaints and many cases had more than one symptom at the same time. The most frequently reported symptom was hearing impairment which affected most patients (61.25%). Nasal obstruction and mouth breathing came next affecting about half of the patients, followed by snoring (47.5%), as showed in table 2.

Table 2: Presenting symptoms in the study.

Symptoms	No. (%)	Age (years)
Hearing impairment	49(61.25)	7.12±3.6
Nasal obstruction and mouth breathing	41(51.25)	9.44±3.1
Snoring	38(47.5)	8.81±2.9
Autophony and tinnitus	11(13.75)	7.91±3.4
Otalgia	9(11.25)	8.48±3.85

Pure tone audiometry

The average PTA for the right ear was 28 ±10.4, while PTA for the left ear was 26 ± 9.7. According to WHO categorization of hearing impairment, 62 ears (34.44%) had normal hearing (25 dB or better), 54 ears (30%) were with mild hearing loss (26 – 40 dB), 38 ears (21.11%) were with moderate hearing loss (41 – 60 dB), and 6 ears with severe hearing loss.

Tympanic membrane examination

Otoendoscopically, the cone light was scattered or absent 63.75% and 16.25%, respectively. The color was amber in 33.75% and blue in 5% of ears. Dull looking was encountered in 60%. The position of TM was normal only in 23.75% of ears and retracted in 57.5%. 88 ears (55%) had impaired motility of TM. Ear bubble and fluid level were reported in 5% and 5.63% of ears, respectively, as shown in table 3.

Table 3 showed the features of OME. One or more of these criteria were encountered in 98 out of 160 examined ears (61.25%). The other 62 ears were considered non-OME.

Table 3: Results of Otoendoscopy in the study.

Feature of the tympanic membrane	Categories	No. of affected ears	%
Cone of light	Shuttered	102	63.75
	Absent	26	16.25
Color	Pale grey	98	61.25
	Amber	54	33.75
	Blue	8	5
Translucency	Dull	96	60
	Translucent	64	40
Position	Retracted	92	57.5
	Pocket	24	15
	Atelectasis	6	3.75
Mobility	Impaired	88	55
Air bubble		8	5
Fluid level		9	5.63

Types of tympanogram

Tympanometry was achieved for a total of 160 ears. Some variation between the right and left ear was observed as showed in (Table 4). For the right ear, 78.75% of ears showed type B tympanogram, while type A and C tympanograms were reported in 6.25% and 15% of ears, respectively. In the left ear, type B tympanogram showed slightly lower frequency and reported in 76.25% of affected ears, while 20% and 3.75% of left ears were found to have type C and type A tympanogram, respectively. Tympanometric curves, or tracings, are classified into 3 main types:

Type A (low probability of effusion +200 to -99 mmH2O) with a sharp peak and normal middle ear pressure as showed in figure 1.

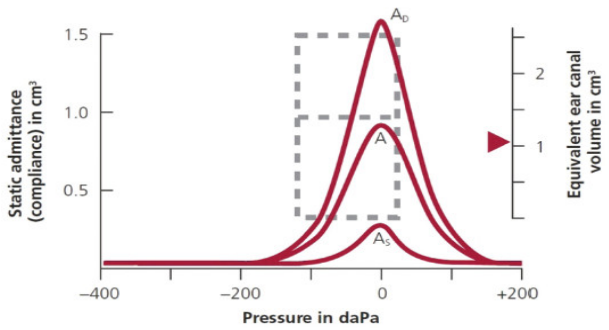

Figure 1:Type A tympanogram result.

Type B (high probability of effusion,) with no discernible peak and a flat tracing as shown in figure 2.

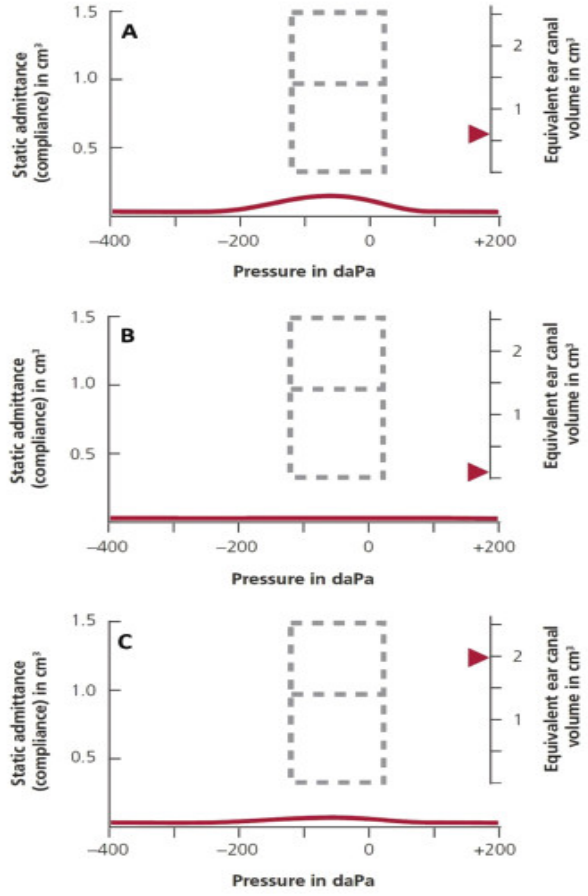

Figure2: Abnormal, type B, tympanogram.

Type C (intermediate probability of effusion: -200 to -400mmH2O) with a discernible peak and negative middle ear pressure as shown in figure 3.

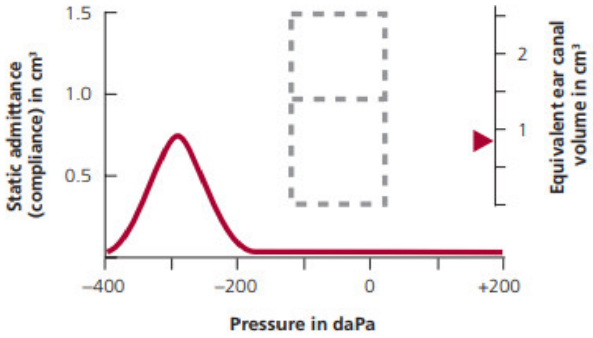

Figure 3: Type C tympanogram with significantly negative peak pressure.

Table 4: Tympanogram types of study (No.=80).

Ear	Tympanogram types	No. (%)
Right ear	Type A	5(6.25)
	Type B	63(78.75)
	Type C	12(15)
Left ear	Type A	3(3.75)
	Type B	61(76.25)
	Type C	16(20)

Myringotomy

Fluid was aspirated from the middle ear during myringotomy in 114 ears (71.15%) and the characteristic of the aspirate was serous in 54 ears (47.37%), mucoid in 60 ears (52.63%), as showed in (Figure 4).

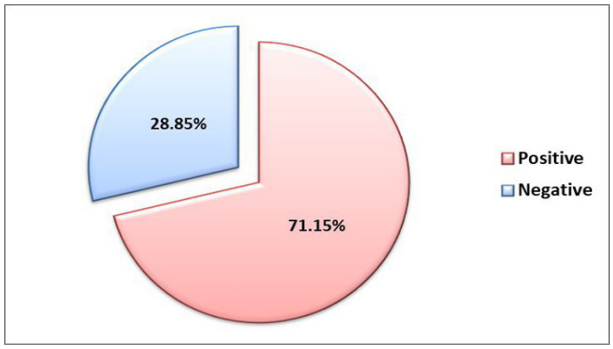

Figure 4: The percentage of positive cases in myringotomy.

Types of fluid according to tympanometry

Type A tympanometry was reported in ٨ ears, of which, 6 (75%)were found to be dry in myringotomy, while 1(1.25%) had a serous fluid and 1(1.25%)also had a mucoid fluid. Out of 124 ears with type B tympanometry, 51(41.13%)contained serous fluid and contained 57(45.97%) mucoid fluid in myringotomy, while 16(12.9%) were found to be dry. Each of serous fluid and mucoid fluid were demonstrated in only 7.14% of ears with type C tympanometry, while (85.41%) of them were found to be dry, with a significant difference ($p<0.05$), as shown in (Table 5) and (Figure 5).

Table 5: Types of fluid in different tympanometric traces.

Tympanometry	Myringotomy			P value
	Fluid		Dry	
	Serous	Mucoid		
	No. (%)			
A (n=8)	1(1.25)	1(1.25)	6 (75)	NS
B (n=124)	51(41.13)	57(45.97)	16(12.9)	<0.05
C (n=28)	2(7.14)	2(7.14)	24(85.41)	<0.05
Total	54	60	46	

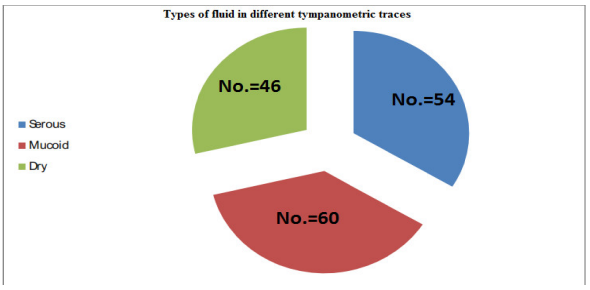

Figure 5:Types of fluid in different tympanometric traces.

Sensitivity and specificity of tympanometry

Out of 114 ears positive for OME according to myringotomy, Type B tympanometry was recorded in 108 ears with the rest 6 ears had other types of tympanometry. For those with a positive result, a grommet was placed, while for those with a negative result, no grommet was placed. Accordingly, the sensitivity and specificity of 94.74% and 65.22% respectively for tympanometry. The PPV= 87.1%, NPV= 83.33%, and the diagnostic accuracy was 86.25% (Table 6).

Table 6: Sensitivity and specificity tympanometry in relation to myringotomy.

		Myringotomy		Total
		Positive (fluid)	Negative (dry)	
Tympanometry	Positive (B)	108	16	124
	Negative (A, C)	6	30	36
	Total	114 (Grommet)	46 (No grommet)	160
Sensitivity = 108/ (108+6) X 100 = 94.74% Specificity= 30/ (30+16) X 100 = 65.22% Positive predictive value = 108/ (108 +16) x 100= 87.1% Negative predictive value = 30/ (6+30) x 100 = 83.33% Diagnostic accuracy = ((108 +30)/ 160) x100 =86.25%				

Sensitivity and specificity otoendoscopy

Table 7 showed the efficiency of otoendoscopy in the diagnosis of OME. A total of 98 ears out of 114 were positive for OME according to this test, while only 16 ears were negative. Accordingly, the sensitivity and specificity of otoendoscopy were 85.96% and 60.87% respectively, PPV= 84.48%, NPV= 63.64%, and the diagnostic accuracy was 62.5%, (Table 7).

Table 7: Sensitivity and specificity otoendoscopy in relation to myringotomy.

According to dull and retracted TM		Myringotomy		Total
		Positive	Negative	
Otoendoscopy	Positive	98	18	116
	Negative	16	28	44
	Total	114	46	160
Sensitivity = 98/ (98+16) x 100 = 85.96% Specificity= 28/ (18+28) x 100 = 60.87% Positive predictive value = 98/ (98 +18) x 100= 84.48% Negative predictive value = 28/ (16+28) x 100 = 63.64% Diagnostic accuracy = ((98 +28)/ 160) x100 =62.5%				

DISCUSSION:

The most frequently reported symptom in the current study was hearing impairment (61.25%), nasal obstruction, and mouth breathing (51.25%) and snoring (47.5%). These results confirmed the findings of some previous local studies such as Al-Juboori *et al*. [19], and Khmmas *et al*. [21].

In the current study, Type A tympanogram was reported in 6.2% and 3.75% in right and left ear, respectively, and type C was reported in15% and 20% in the right and left ear respectively, while Type B was found in 78.75% in the right ears and 76.25% in the left ears with normal canal volume. In a similar study in Kurdistan, Type B was accounting for 80% of cases, while Type A and C represented 5.8% and 14.2% of cases respectively [16]. In a local study, the frequency of Type A: 22.9%, Type B: 61.9%, and Type C: 15.2% [22]. It seems that several factors can interfere with the results of tympanometric traces in children with OME, and these factors are age and degree of cooperation of the child, duration of OME, and anatomical variations between different ears [23].

In the current study, the mostly affected age group was 5-7 years accounting for 56.25% of cases. In accordance with this result is a local study in Kurdistan, in which the age group 5-9 years was the mostly affected accounting for 48.3% of the total cases [16]. Globally, Rishi and Praksab [17] also found that 56.8% of patients with OME were within age group 5-9 years.

There was no marked variation between males and females in the current study. This result goes with most previous studies in that there was no significant difference in OME incidence between the two genders [18,19].

Passive smoking and allergy were the predisposing factors for OME in the current study.

A significant correlation between passive smoking and OME was confirmed by many previous studies which used the serum, salivary, and urinary nicotine as an indicator of passive smoke exposure [19]. Such a result is important because it reflects the higher rate of smoking in Iraqi families and parents are unaware of the hazards of passive smoking on their children.

On the other hand, allergy was frequently reported as a risk factor for OME. In one study, 78% of patients aged 1.5–9 years with recurrent OME were sensitized to one or more food allergens. An elimination diet of the suspected food resulted in the amelioration of OME in 86% of patients while reintroduction provoked recurrence in 94% of patients over 16 weeks [20].

The most important finding regarding TM in the present study was the presence of amber color in 33.75% and blue color in 5% of ears. Dull TM was encountered in 60%. The position of TM was retracted in 57.5%, and 88 ears (55%) had impaired motility of TM. Ear bubble and fluid level were reported in 5% and 5.63% of ears, respectively. Khmmas *et al*. [21] in their study reported that the mobility of TM was impaired in 70% of examined ears. In another local study by Mohammed *et al*. [24], the TM was found to be retracted in 85 % of ears. The color of TM was amber in 28.5% and blue in 2.5%. The translucency of TM was dull in 69%.

Generally, OME is highly suspected when one or more of the following findings are encountered during otoscopy: dull tympanic membrane, yellow or amber color, decreased mobility, presence of air-fluid level or bubbles, and retracted tympanic membrane [15].

The sensitivity and specificity of tympanometry in the detection of OME in the current study were

94.74% and 65.22% respectively, with the diagnostic accuracy was 86.25%. Different studies in the different areas in the world showed conflicting results regarding the performance of tympanometry. The reported sensitivities ranged from 51 to 91% while the specificities ranged from 66 to 100% [25]. In Mohammed's study [24], the sensitivity was 82%, specificity was 52% and accuracy was 71%. However, higher values were reported in Muttalib's study in which the sensitivity, specificity PPV, NPV were 97.2%, 57.3%, 55.3%, and 97.5% respectively [22].

These variations can be explained by many factors that affect the accuracy of tympanometry. Since the episodes of AOM can be associated with loss elasticity of TM and produce a false B trace [26]. Moreover, tympanosclerosis can give rise to a Type B tympanometry even in the lack of effusion. Thus, a false-positive result is obtained [27]. Also, in some cases, the effusion may not fill the middle ear cleft, and the TM has some movement during tympanometry [26]. Finally, the type of fluid (serous or mucoid) can influence the trace. In this regard, Liu *et al*. [25] suggested that peak traces may occur in the presence of serous rather than mucoid fluid, but such association was not seen in the current study.

The sensitivity and specificity of otoscopy in the current study were 85.96% and 60.87% respectively, PPV= 84.48%, NPV= 63.64%, and the diagnostic accuracy was 62.5%. These results are compatible with the results of previous studies in this regard. The study of Khammas *et al*. [21] showed that the sensitivity and specificity of this diagnostic modality were 85.7% and 60.5% respectively. Likewise, Mohammed *et al*. [24] demonstrated a sensitivity of 82% and a specificity of 52% for otoscopy in the detection of OME.

CONCLUSION:

Considering the myringotomy as a gold standard, the sensitivity and specificity of tympanometry were higher than that in the otoscopy. Neither tympanometry nor otoendoscopy can be a reliable method for the definitive diagnosis of OME. However, these tools, especially tympanometry can be used as a screening method for the detection of OME in children before proceeding to myringotomy.

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