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Validity of Tympanometry Versus Myringotomy Findings in Pediatric Middle Ear Effusion

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Abstract

Background and objectives: Otitis media with effusion is a common but treatable cause of hearing impairment in children. It leads to delay in speech acquisition and poor performance at school. Correct diagnosis at an early stage with history and clinical examination and tympanometry is needed

We evaluated the role of tympanometry; type B, flat curve; in predicting middle ear effusion by comparing the findings with those of myringotomies in children with otitis media with effusion. **Methods:** This is a prospective case- series study conducted at the department of ENT, Rizgary Teaching Hospital. The test population comprised 39 boys and 21 girls, ages ranged (2years- 12 years). Patients with suspicion of otitis media with effusion underwent tympanometry. Its findings were compared with findings of the respective myringotomies. From the data collected sensitivity, specificity, positive predictive value and negative predictive values were estimated **Results:** A total of 120 ears from 60 patients were operated. The commonest age group affected by otitis media with effusion was 5-9 years. Type B tympanogram with flat curve and normal canal volume was obtained in 80.0% of the ears. The diagnostic value of tympanometry was; Sensitivity 90.8%, Specificity 68.2%, positive predictive value 92.7%, negative predictive value 62.5%. **Conclusions:** Otitis media with effusion iscommon in age group 5-9 years. We concluded that tympanometry is a valid test providing a high sensitivity, specificity and positive predictive value for middle ear effusion.

Keywords: Otitis media with effusion; Tympanometry; Myringotomy.

Introduction

Otitis media with effusion (OME) is defined as fluid accumulation in the middle ear and, sometimes, the mastoid air cell system without signs or symptoms of ear infection[1]. Symptoms usually involve hearing loss or aural fullness but typically do not involve pain or fever. The condition is said to be chronic when the fluid accumulation persists beyond 12 weeks[2]. Otitis media with effusion is one of the most common diseases of the childhood that demands visits to the otorhinolaryngologist. It is characterized by the presence of fluid in the middle ear that may present in the form of clear to thick and brownish fluid with high protein content, originated in the secretory epithelium[3]. Though it is described with various synonyms like seromucotympanum, glue ear, serous otitis media, secretory otitis media but the most widely accepted terminology is OME[4].

Otitis media with effusion can occur during the resolution of acute otitis media once the acute inflammation phase has been resolved. Among children who have had an episode of acute otitis media, as many as 45% have persistent effusion after 1 month, but this number decreases to 10% after 3 months[5]. The physiopathologic basis is intimately connected to the disorder of the Eustachian tube, anatomic disturbances or inflammatory and histological changes[6, 7]. Children with Eustachian tube dysfunction, adenoid hyperplasia, nasal allergy, Down syndrome and craniofacial anomalies are at high risk for developing OME[8]. The prevalence OME in childhood is related to the age of the child and the season of the year. It is bimodal with the first and largest peak of approximately 20 % at two years of age[9]. And a second peak of approximately 16 % at five years of age.

The clinical diagnosis of OME is made by history, otoscopy, pneumatic otoscopy and impedance audiometry. Tympanometry is an objective test used to evaluate the condition of the middle ear and mobility of the tympanic membrane TM and the ossicular chain by making alteration of air pressure in the ear canal[10]. Its performance is recommended in association with more qualitative information (e.g. history, appearance and mobility of the tympanic membrane) in the assessment of otitis media with effusion. Type B tympanogram with flat curve and normal canal volume is considered diagnostic for OME[11].

Tympanograms are classified according to the shape of the plot. A normal (left) is labeled Type A. There is a normal pressure in the middle ear with normal mobility of the eardrum and the ossicles. Type C reveal negative pressure of middle ear and type B reveals fluid in the middle ear, perforation or scarring of tympanic membrane[10].

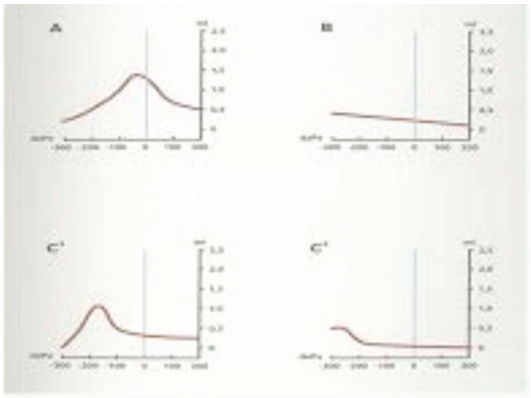

Figure (1): Jerger classification system of tympanometry

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The treatment of OME may be medical or surgical. The standard treatment of patients with type B curve is surgical with myringotomy with or without ventilation tube insertion is considered the best modality of management in cases of OME that do not resolve after 3 months. This is because 50% of cases will resolve in 3 months by its own[12]. Fluid or glue that is obtained in myringotomy is the gold standard method of diagnosing the condition; but clinically diagnosed cases of OME can have thick or thin fluid on myringotomy or even can have dry tap[13]. Analyzing papers with the findings at myringotomy (soon after tympanometry), suggest that type B is frequently associated with OME, type A is infrequently associated with OME and type C falls in between[10].

The aim of the study is to assess the validity of tympanometry; type B, flat curve; in predicting middle ear effusion (sensitivity, specificity, positive and negative predictive values) by comparing the results with the operative findings (fluid found in the middle ear at the time of myringotomy as a 'gold-standard') in children with otitis media with effusion.

Patients and methods:

This is a prospective validity study conducted at the department of ENT, Rizgary Teaching Hospital, Erbil from January 2016 to December 2017. The test population comprised 39 boys and 21 girls; included patients in the age range of 2-12 years with mean age of 6 years. All underwent tympanometry followed by myringotomies and included patients with types A, B and C tympanograms with clinical evidence of OME. We excluded from our study patients who turned to be normal otoscopically with confirmation by type A tympanometry preoperatively, craniofacial abnormalities, cleft palates, Down`s syndrome, chronic immune deficiencies, patients with history of recent respiratory tract infection (within the last two – three weeks), children with coagulopathy and children with active otitis externa.

All clinically suspected patients underwent tympanometry (Happersberger otopront GmbH, Langgesse 90, D 65329Hohenstein.Germany) at the time of the initial evaluation and a second tympanometry 1-2 days later. The tympanograms were obtained from our department using 226 Hz probe tone. Normal ear canal volume was taken as 0.3-1 mL. The curve was considered flat when it had no discernible peak over a pressure range of +200 daPa to -400 daPa. Pure Tone Audiogram (PTA) was also obtained in selected children.

Informed consents were obtained from child`s parent(s) before surgery after adequate explanation of the procedure. The study was approved by Kurdistan board for medical specialty. All myringotomies were done under nitrous oxide free general anesthesia, with endotracheal intubation. Using an otomicroscope, myringotomy performed. In the case of presence of fluid, the fluid was aspirated then a tympanostomy tube was inserted through the myringotomy. The presence or absence of any middle ear fluid was recorded as well as the type of the middle ear fluid. Type B tympanogram with flat curve was taken as conclusive evidence for the presence of fluid in the middle ear space. The operative findings at myringotomy were recorded and thus labeled as: I. True Positive (TP) when fluid was present and II. False Positive (FP) when no fluid was aspirated. In cases where the tympanograms were either Type A or Type C, the findings were categorized as: III. True Negative (TN) means no fluid was aspirated and IV False Negative (FN) means fluid was present. From these results the sensitivity, specificity; positive and negative predictive values of type B tympanometry were calculated.

Results: The study sample was composed of 60 children. Their mean age + SD were 6.5 + 3.1 years, ranging from 2 to 12 years. The median age was 6 years. Nearly half (48.3%) of the children aged 5-9 years, 28.3% aged less than five years, and 23.3% aged ≥ 10 years (Table 1). The table shows two thirds of children (65%) were males. The male: female ratio was 1.85: 1.

Table (1): Age and gender distribution.

	No. of patients	(%)
Age (years)		
< 5	17	(28.3)
5-9	29	(48.3)
≥ 10	14	(23.3)
Gender		
Male	39	(65.0)
Female	21	(35.0)
Total	60	(100.0)

The tympanometry findings were as follows: Normal 5.8%, effusion 80%, and Eustachian tube obstruction 14.2%, while the myringotomy findings were: dry 18.3%, glue 57.5%, and serous 24.2% as presented in Table 2.

Table (2): Tympanometry and myringotomy findings.

	No. of ears	(%)
Tympanometry findings		
A	7	5.8
B	96	80.0
C	17	14.2
Myringotomy findings		
Dry	22	18.3
Glue	69	57.5
Serous	29	24.2
Total	120	100.0

Table 3 shows that 71.4% of type A tympanometry found to be normal (dry) by myringotomy, and the rest had serous effusion. Only 7.3% of type B tympanometry found to have a dry tap by myringotomy. Regarding type C, 58.8%

had dry tap, 23.5% had glue effusion, and 17.6% had serous effusion by myringotomy.

Table (3): Findings of tympanometry compared with myringotomy findings.

Tympanometry types	Myringotomy findings: Dry		Glue		Serous		Total	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
A	5	(71.4)	2	(28.6)	0	(0.0)	7	(100.0)
B	7	(7.3)	63	(65.6)	26	(27.1)	96	(100.0)
C	10	(58.8)	4	(23.5)	3	(17.6)	17	(100.0)
Total	22	(18.3)	69	(57.5)	29	(24.2)	120	(100.0)

Table 4 and Figure 2 show that the validity indicators of tympanometry were as follows: Sensitivity 90.8%, specificity 68.2%, predictive value positive 92.7%, predictive value negative 62.5%, and total agreement 86.7%. No significant differences were detected between the two tests' results p = 0.804.

Table (4): Assessment of the validity of tympanometry compared with myringotomy (as a gold standard).

Tympanometry findings	Myringotomy findings: Positive (fluid)	Negative	Total	P (McNemar test)
Positive (fluid)	89	7	96	0.804
Negative	9	15	24	
Total	98	22	120	

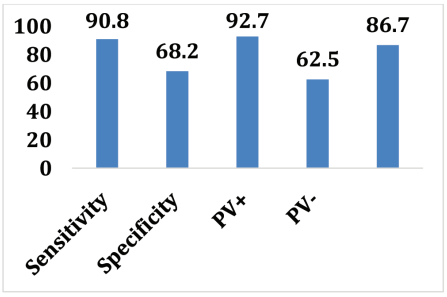

Figure (2): Validity indicators.

Discussion

Tympanometry has been demonstrated to be a more sensitive and reliable test[14]. It is a widely utilized tool for the diagnosis of middle ear effusion; however the accepted 'gold standard' for diagnosing middle ear effusion is the otomicroscopic visualization of effusion demonstrated on myringotomy[15].

The majority of the patients were in the age group (5 – 9 years) contributing to 48.3% of the entire sample. Similarly, Risbi and Prakasb reported that the age of their patients was 12 years and most of them 56.8% were 5-9 years of age[16]. It can be concluded that middle ear effusion is common during the school age and the age of the most intensive period of language development, which a concern is given the risk of hearing loss associated with it.

The study revealed that the sensitivity and specificity of tympanometry; type B, flat curve were 90.8% and 68.2% respectively. These results indicate that the test is showing a high sensitivity rate and medium specificity rate. A sensitive test is more useful in detecting the disease in screening processes and minimizing false negative diagnoses. A number of studies have assessed the validity of tympanometry when compared to this 'gold standard [14, 15, 17, 18-23]. Previous studies recorded sensitivities for tympanometry of between 0.51 15 to 0.91 17, with specificities between 0.66 22 to 1.00 15. The absence of nitrous oxide as an anaesthetic agent will theoretically cause a decrease in the number of false positive Type B tympanograms as the nitrous oxide does not cause displacement of the middle ear effusion prior to myringotomy. This is in turn should raise the specificity and positive predictive value of tympanometry. However, the specificity of 68.2% that we recorded in our study falls within the mid-range of those two studies results reported by Sassen [22] and Szucs[23] which were 0.66 and 0.79 respectively; and they stated to have usednitrous oxide as an anaesthetic agent and this may be due to the small A and C type samples (only 24 ears) in comparison to the relatively the large B sample (96 ears). Similarly, the positive predictive value of a Type B tympanogram should be higher in studies where nitrous oxide is not used. This study shows a positive predictive value of 92.7%. Again this is in the mid-range of previously published results, but higher than those that definitely used nitrous oxide during anaesthesia [22, 23]. The possible explanation of the variable results of tympanometry regarding its sensitivity and specificity may be attributed to the following factors: an explanation for the 'false negative' peaked traces is that, in some cases, an effusion may not totally 'fill' the middle ear cleft, allowing some movement of the tympanic membrane on tympanometry[24]. Watters[17] suggested that peaked traces may occur in the presence of a serous, rather than a mucoid effusion. In this study in all peaked positives (6 ears, 2 type A and 4 type C tympanogram), the fluids found were thin (serous) type.

Conversely, there may be a number of explanations for 'false positive' type B traces. Reasons for this is related to: recumbence position that may lead to fluid displacement to the epitympanum and mastoid or through Eustachian tube; technical causes include those either related to technical fault or anatomical causes which may give type B curve, these include: occult perforation of the tympanic membrane, non air tight seal probe, probe facing the canal wall. Episodes of repeated acute otitis media can lead to a loss of elastic fibers from the tympanic membrane and produce a 'deep curve' A wave on tympanometry that could be misinterpreted as a type B trace by the unwary[24]. Finally, tympanosclerosis can give rise to a type B Tympanogram in the absence of effusion and may be responsible for a proportion of the false positive readings.

Conclusions

OME is common in age group 5-9years.Tympanogram Type B with normal canal volume is highly sensitive in diagnosing this condition. The accuracy of tympanometry is assessed by its sensitivity and specificity. However due to occurrence of false positive results, final decision regarding management should be made on the basis of the clinical findings and other supportive audiological tests.

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