Research Article

Diagnostic accuracy of otitis media with effusion in children

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Abstract

Background: Otitis media with effusion is a common disease and causes hearing disability that necessitates early and accurate management.
Objectives: Comparison of standard otoscopic tympanic membrane finding, pneumatic otoscopy and tympanometric results with myringotomy finding.
Patients and Methods: A prospective study of 60 children (120) ears with a suspicion to have otitis media with effusion that have been done from 1st of Jan 2014 to the 1st of Jan 2015, at Otolaryngology Department in Al-Yarmouk Teaching Hospital-Baghdad, all patients were underwent a clinical assessment by standard otoscopy, pneumatic otoscopy and audiological assessment by tympanometry, then we compared all results with myringotomy finding as a reference standard for predicting the presence or absence of fluid within the middle ear.
Results: there were 53% males and 47% females. Among them 63% were in age group 5-8 years. The main presenting symptom was hearing impairment (90%). Retraction of the tympanic membrane was the main otoscopic findings in 83.5%, from which fluid at myringotomy found in 72%. Type B tympanogram in 47.5% of which 88% revealed fluid in taping. The Sensitivity, specificity and accuracy of tympanogram (A and B) were 89%, 63% and 83% respectively, and for type C1 and C2 tympanograms the results was variable, while for clinical assessment (otoscopy) they were 85.7%, 60.5% and 76.7% respectively, and in (pneumatic otoscopy) the results was 97%, 30% and 73% respectively, and in cases of a combined clinical and tympanometric assessment, the results was 97%, 52% and 86% respectively.
Conclusion: Conjunction of tympanometry and pneumatic otoscopy examination increase accuracy.

Key words: Otitis media with effusion; Otoscopy; Pneumatic otoscopy; Tympanometry; Myringotomy.

INTRODUCTION

Otitis media with effusion (OME) is the chronic accumulation of mucus within the middle ear and sometimes the mastoid air cell system, the time that the fluid has to be present for the condition to be chronic is usually taken as 12 weeks, in children it usually presents because of the associated hearing impairment, there were many synonyms have been and are used for this condition, these include: “glue ear”, and “chronic non purulent otitis media, 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, also it is around twice as many children being diagnosed with OME in the winter as opposed to the summer [1]. An untreated OME causes hearing impairment with potential subsequent delay in speech and cognitive development, especially in young children [2]. OME is difficult to diagnose by standard otoscopy alone and an adjunctive tool should be used to improve diagnostic accuracy, there are various tools have been proposed for the diagnosis of OME other than otoscopy in order to improve diagnostic accuracy, these include micro-otoscopy, tympanometry and pneumatic otoscopy, myringotomy[3]. The use of pneumatic otoscopy to demonstrate decreased mobility of the tympanic membrane is considered an important primary diagnostic method, other factors that help confirm the diagnosis include type B tympanogram (flat curve), but still tympanocentesis which is usually performed at the

time of myringotomy, remains the gold standard for diagnosing OME [4].

The aims of the study: 1) to assess the accuracy of clinical diagnosis (otoscopy and pneumatic otoscopy), 2) to assess the accuracy of different types of tympanograms, 3) to correlate between them and the myringotomy findings.

PATIENTS AND METHODS

This is prospective study of 60 patients (120 ears), aged 3- 12 years attended at Otolaryngology Department in Al-Yarmouk Teaching Hospital –Baghdad with suspension of having OME, in period from the 1st of January 2014 to the 1st of January 2015, all children were subjected for proper ENT examination using otoscopy, pneumatic otoscopy, audiological assessment by tympanometry and the data were documented on special formula prepared for that reason contained a detailed parameters such as: Otoscopic examination: like tympanic membrane (position, color, translucency, cone of light, and presence of air bubbles or fluid level), and the mobility of tympanic membrane was assessed with pneumatic otoscope (which has a magnification of 2.5 times convex lens) as either mobile, impaired or immobile tympanic membrane, then tympanometry was performed to all studied children regardless to the otoscopic examination, by a Macio M44 tympanometer of 226 Hz (low frequency pressure probe tone) , through using A Fiellau – Nikolajson [5] classification for tympanograms, as Peaked curves: Type A : maximum compliance the same or more than 0.2 ml with a middle ear pressure of (-99 to +200 dapa). Type C1: maximum compliance the same or more than 0.2 ml with a middle ear pressure of (-100 to -199 dapa). Type C2: maximum compliance the same or more than 0.2 ml with a middle ear pressure of (- 200 to - 400 dapa). Non-peaked curve: Type B: maximum compliance less than 0.2 ml or middle ear pressure less than (- 400 dapa), and for the purpose of analysis, type A and C1 curves were classified as normal, and type B and C2 curves were classified as abnormal [6]. This study was approved by the Ethic committee of our institution, and after explanation and taking the consent from their parents they underwent myringotomy under general anesthesia, as a part of other surgical procedures, and by using operating microscope (Carl Zeis- Germany/ using 250 mm lenses) the fluid was obtained through a radial incision which made in the anterior inferior quadrant of the tympanic membrane. The results of standard otoscopy, pneumatic otoscopy, and that of tympanometry were calculated, and their diagnostic accuracy was determined by the confirmation of middle ear effusion based on myringotomy findings as a referenced standard by applying the parameters as the sensitivity, specificity and accuracy values for the analysis.

RESULT

Among 60 children there were 32 boys (53%), and 28 girls (47%), the most common age group was 5-8 years, were their 38 children (63%), and the hearing impairment was the main presenting symptom as it was found in 54 children (90%).

1-Tympanic membrane examination:

Table 1 shows the findings during tympanic membrane examination by using otoscopy and pneumatic otoscopy and the findings at myringotomy by operating microscope.

The mobility of tympanic membrane which was detected by Siegel's pneumatic otoscopy, revealed that 15 ears (12.5%) with normal mobility, of those only 2ears (13%) had middle ear effusion, while 84 ears (70%) had impaired mobility, of which 59 ears (70%) had fluid in the middle ear and the rest 25 ears (30%) were dry. At the same time immobile tympanic membrane was detected in 21 ears (17.5%), of which 16 ears (76%) had effusion while 5 ears (24%) were dry.

Table (1) Results of tympanic membrane examination and myringotomy finding.

Tympanic membrane examination		NO	%	Myringotomy finding			
				dry	%	fluid	%
position	normal retracted pocket atelectasis	9 100 5 6	7.5 83.5 4 5	6 28 4 5	66.5 28 80 83	3 72 1 1	33.5 72 20 17
color	pale grey Amber Blue	80 37 3	66.5 31 2.5	36 7 0	45 19 0	44 30 3	55 81 100
translucency	dull translucent	83 37	69 31	17 26	20.5 70	66 11	79.5 30
cone of light	normal shuttered absent	0 99 21	0 82.5 17.5	- 30 13	- 30 62	- 69 8	- 70 38
air bubbles		8	6.5	0	0	8	100
fluid level		9	7.5	2	22	7	78
mobility	normal impaired immobile	15 84 21	12.5 70 17.5	13 25 5	87 30 24	2 59 16	13 70 76

2-Tympanogram types and myringotomy fluid:

In type A curve agreement to findings at myringotomy occurred in 12 ears (67%). Fifty seven ears (47.5%) demonstrated type B curve which suggest presence of effusion. Fifty ears (88%) of these cases were in agreement with myringotomy findings. There were 45 ears (37.5%) with type C1, and in C2 curves there were 21 ears (47%) revealed effusion, the relation between tympanometry curves and results of myringotomy, it shown in figure 1.

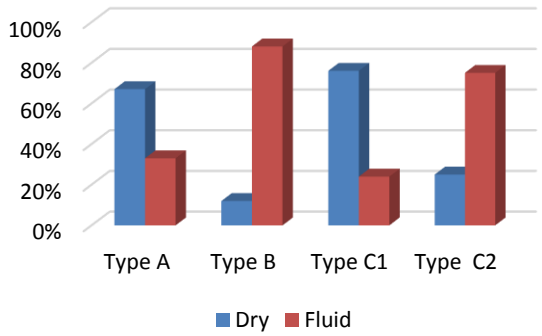

Figure (1) Comparison of tympanogram types and the myringotomy finding

3-Tympanometry sensitivity, specificity and accuracy:

By using a 2 x 2 matrix sensitivity and specificity calculated for the detection of OME with myringotomy findings as the reference standard, for type A and B curves the results were 89% and 63% respectively, and when add the transition type C tympanogram into analysis and consider them negative then sensitivity will be 65% and specificity will be 83.5%, but when consider C2 positive in addition to type B tympanogram then the result will be the sensitivity: 84% and specificity: 72%, as it shown in table 2.

Table (2) Tympanometry sensitivity and specificity in the detection of OME with surgical findings as the reference standard.

Tympanogram	Myringotomy (OME present)	Myringotomy (OME absent)
B	**True positive 50**	**False positive 7**
A	**False negative 6**	**True negative 12**
A+C	**False negative 27**	**True negative 36**
B+C2	**True positive 65**	**False positive 12**
A+C1	**False negative 12**	**True negative 31**

The accuracy of tympanometry was calculated in regard to type A and B curves only and found to be 83%.

4-Otoscopic sensitivity, specificity and accuracy:

Regarding standard otoscopic examination (translucent versus dull) we have sensitivity of (85.7%) and specificity of (60.5%) table 3.

Table (3) Otoscopic sensitivity and specificity in the detection of OME with surgical findings as the reference standard.

Otoscopy	Myringotomy (OME present)	Myringotomy (OME absent)
TM dull (OME suspect present)	**66**	**17**
TM translucent (OME suspect absent)	**11**	**26**

5-Pneomatic otoscopy sensitivity, specificity and accuracy:

Regarding pneumatic otoscopy: the sensitivity was 97%, and the specificity was 30%, as it shown in table 4

Table (4) Pneumatic otoscopy (TM Mobility) sensitivity and specificity in the detection of OME with surgical finding as the reference standard.

Pneumatic Otoscopy	Myringotomy (OME present)	Myringotomy (OME absent)
Impaired or immobile TM (OME suspect present.)	**True positive 75**	**False positive 30**
Mobile TM (OME suspect absent.)	**False negative 2**	**True negative 13**

6-Combined clinical and tympanometric sensitivity, specificity and accuracy:

The combination of clinical (pneumatic otoscopy) and tympanometry values as shown in table 5, this resulted in an increase in sensitivity: 97% and accuracy: 86% but a decrease in specificity: 52%.

Table (5) Combined pneumatic otoscopy and tympanometry sensitivity and specificity in the detection of OME with surgical findings as the reference standard.

Tympanogram & Pneumatic Otoscope	Myringotomy (OME present)	Myringotomy (OME absent)
B and C2 Impaired or immobile TM	**True positive 65**	**False positive 10**
A and C1 Mobile TM	**False negative 2**	**True negative 11**

DISCUSSION

The current study reported that, (63%) were 5-8 years of age, with a male predominance (53%). This agreed with other studies, as Rishi and Prakash A, study which reported that, most of the children (56.8%) were in 5-8

years of age [7]. Ahmad et al, study had shown that (54.4%) of children were males and (45.6%) were females [8], and Dong-Hee L and Sang-Won Y, had shown 33 males and 18 females [9], however it concluded that it is likely to be a little difference if any in risk for boys compared to girls [1], however the current study do not represent true prevalence of the disease as it was performed in only hospital. Regard to the most common presenting symptom, it was hearing impairment (90%), also Ahmad et al, study shown that, the main presenting symptom was hearing impairment (47.2%) [8], while Syed et al, study shown that, the common presenting symptom was fullness in the ear (50.3%) [10]. The hearing impairment was noticed by the parents or teacher due to scholastic retardation, or it suggested by seeming lack of attentiveness, failure to respond to normal conversational level speech.

1-Tympanic membrane examination:

Retracted tympanic membrane was found to be the commonest otoscopic sign (83%), this agrees with Ahmad et a, study, in which it was (91.7%) [8], and by Orji, FT and Mgbor NC study which showed that it was the most specific otologic finding in detection of OME [11], while Syed et al, study found that, the most common sign was dull eardrum (72.18%) [10].

The current study revealed that (72%) of retracted tympanic membrane, and (80%) of dull tympanic membrane showed fluid by myringotomy, these results were similar to the study done Hamed et al, which reported that (68%) of retracted TM, and (74%) of dull TM, showed fluid by myringotomy[12].

It is generally accepted that the middle ear fluid decreases the mobility of TM mainly due to increased mass on the TM, reduction middle ear air space, and abnormal pressure in the middle ear cavity [13].

Regard to the color of tympanic membrane, the current study indicated that, the color of the ear drum carry less diagnostic value, the same findings and conclusions was reported by a study done by Hamed et al [12], and by a study done by Daly KA et al, which confirmed that the color of the tympanic membrane is of lesser importance than the position and mobility [14],these observation was confirmed by a study done by De Melker RA, which reported that serious retraction of the eardrum and absence of mobility under positive pressure were the most predictive features but the color of the tympanum did not show any relation to effusion[15].

2- Sensitivity, Specificity and Accuracy of tympanic membrane examination:

Loss of translucency is a feature suggestive of OME, with sensitivity of (85.7%), specificity of (60.5%) and accuracy of (76.7%). in current study the standard otoscopic examination had high sensitivity but low specificity and these results were almost similar to that of Hamed et al, study that shown the sensitivity was (82%), specificity was (52%) and accuracy was (71%) [12], and Dong-Hee L and Sang-Won Y study, reported a sensitivity of (89.7%) and low specificity of (71.4%) [9].

Generally, most clinicians who use otoscope have good sensitivity for the presence of middle ear effusion, but being confident about the absence of effusion (specificity) takes experience and practice [16].

Regard to the cone of light, it was appeared to be shuttered in (82.5%) from which (70%) were contained fluid, and it was absent in (17.5%) of which (38%) contained fluid confirmed by myringotomy.

These results were comparable to that of study done Hamed et al, which reported that, the cone of light was found in (80%) from which (69%) contained fluid which being approved by taping, and it was absent in (20 %) of which (37.5%) confirmed to had fluid by myringotomy [12], so the current study found that cone of light assessment of less importance in diagnosis of OME. It reported that, the absence of the cone of light does not necessarily signify an ear disorder, as it could be due to the slope of the tympanic membrane or the shape of the external ear canal [17].

The presence of an air bubbles and fluid level carry important sign for detection of OME [12].

The calculations of the sensitivity, the specificity, and the accuracy for pneumatic otoscopy were (97%), (30%), and (73%) respectively. Dong-Hee L and Sang-Won Y shown in their study that sensitivity was (97.2%) and specificity was (38.5%) [9]. Finitzo et al,study found that, the sensitivity was (93%) and specificity was (58%) [18].

The current study found that the cloudiness and mobility of the tympanic membrane show the highest sensitivity and accuracy with variable specificity in contrast to other clinical findings, the same observation was found in a study done by De Melker RA which revealed that cloudiness and mobility of the tympanic membrane had the highest sensitivity and specificity [15].

3- Tympanometry types:

The most common cause of flattened, or type B tracing, with a low static admittance, when the ear canal volume is normal is decreased mobility of the tympanic membrane secondary to middle ear fluid [19], so type B tympanogram is the best diagnostic tool for predicting OME in the children [20]. The current study found that (88%) of type B curve and (33%) of type A curve were

revealed positive by taping, these results looks comparable to other studies, as study done by Hamed et al, which reported that (89.5%), of type B curve and (27%) of type A curve were positive by taping [12], and also by a study done Ahmad et al, which showed that in tympanograms of type B (92.2%), and type A (2.8%) revealed fluid which confirmed by myringotomy[8]. Fish B M et al, study concluded that not all of the ears which their tympanometer registered as having 'type B' traces could expected to had effusions, since (13 %) of type B tympanogram were dry at myringotomy, in these cases there had been displacement of fluid from the middle ear by N2O during anesthesia [21], and when a type A tympanogram was confirmed by the presence fluid at myringotomy was probably due to small amount of fluid was found [22].

The most probably reasons for dry tap by myringotomy, despite having fluid in middle ear cavity are very thick fluid, located in dependent areas, or by Nitrous Oxide action [7].

4- Tympanometry Sensitivity, Specificity and Accuracy:

Regard to type B tympanogram , and type A tympanogram the current study revealed that the sensitivity was (89%), specificity was (63%), and accuracy was (83%), these findings were close to the results of other studies, as finitzo et al, which revealed a results; sensitivity was (90%) and specificity was (86%) for tympanometry [18], study done by Palmu AA and Syrijanen R, had shown that, the sensitivity of type B tympanogram was (61%) and specificity (99%) [23], and study done by Shaio A S, and YC Guo, which reported that type B tympanogram with sensitivity of (96.6%) and specificity of (99%) [24].

Analyzing papers with findings at myringotomy as the reference standard, suggest that a type B tympnogram is frequently associated with OME, a type A is infrequently associated with OME and a type C falls in between [1]. It being a well-documented method for the diagnosis of OME, tympanometry has a sensitivity varying between (82–90%) and specificity between (68–98%) relative to findings in myringotomy [25, 26].

Analyzing the result of type B tympanogram versus type A and C tympanogram ,it shown that, the sensitivity was (65%) and the specificity was (83.5%) , these result looks comparable to those of other studies as Finitzo et al, were the sensitivity was (57%), and the specificity was (94%) [18], and when analyzing the result of type A and C1 tympanograms versus type B and C2 tympanograms, it shown that of a sensitivity was (84%) and a specificity was (72%), as a parameters in detecting OME, while on other hand, a study done by Miia K Laine et al. which grouped result of type C2 and B tympanograms (the positive test result) contrasted with type A and C1 tympanograms (the negative test result), as a parameters in excluding OME, it showed that, the sensitivity was (84%), and the specificity was (87%) [27].

This wide range of values can only be partly explained by the differing proportion of ears with OME and the fact that the anesthetic can itself aerate the middle ear giving a 'false' dry tap [1].

5- Sensitivity, Specificity and Accuracy of combined Clinical and Tympanometric results:

In combination of clinical (pneumatic otoscopy) and tympanometry, the results revealed a sensitivity of (97%), a specificity of (52%) and the accuracy of (86%), these findings was agreed with results of other studies, like Finitzo et al, which revealed both sensitivity and specificity above (90%) [14], and Harris et al, study which shown that, they were between (80% -100%) [28].

Using pneumatic otoscopy with tympanometry improves the accuracy of diagnosis because many abnormalities of the eardrum and ear canal that might cause an abnormal tracing can be visualized, determining the presence of obstructing cerumen in the canal, and characteristics of the tympanic membrane (e.g., color, mobility, position, and translucency) are helpful in correlating tympanometry findings with clinical disease, the two tests can be complementary, because pneumatic otoscopy provides a qualitative measure of tympanic membrane mobility (i.e., does the tympanic membrane move with insufflations) and tympanometry produces more quantitative information (e.g., numeric and graphic data about generated positive and negative pressures, absorption of acoustic energy by the middle ear system, ear canal volume) [29], although myringotomy is a 'gold-standard' method for confirmation (effusion or no effusion),but as it is an invasive procedure, its application is not possible in a primary care setting for ethical and practical reasons [15].

CONCLUSIONS

- Clinical diagnosis (otoscopy and pneumatic otoscopy) has good sensitivity and accuracy.
- Tympanogram type A and B carry highest accuracy among other types of tympanogram consider to myringtomy confirmation.
- Conjunction of tympanometry and pneumatic otoscopy examination increase accuracy.
- All tools are significant in diagnosis of OME, but accuracy found more in tympanometry than otoscopy and pneumatic otoscopy depending on sensitivity and specificity tests when compared with myringotomy results.

RECOMMENDATION

It is recommended for the availability of tools and devices required for examining the ear for purpose to diagnose OME in the health care centers preliminary as well as training on these devices for doctors working place.

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