Middle ear effusion: tympanometry versus operative findings

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ABSTRACT

Objective: To evaluate the role of tympanometry in predicting middle ear effusion by comparing results with the operative findings.
Design: A descriptive study concerned with 105 ears (57 patients) diagnosed as middle ear effusion by tympanometry; type B, flat curve; that underwent myringotomy operation (with or without ventilation tube insertion).
Setting: Department of ENT-Al-Salam Teaching Hospital/Mosul for the period (April 2003 to September 2004). Tympanometry was performed in the Outpatient Clinic of Al-Jamhoori Teaching Hospital.
Subjects: The study included 36 males and 21 females with a ratio of 1.7:1. The average age was 6 years with a range of 3-12 years.
Methods: The parameters analyzed included age, sex and tympanometric results. Matching between the suspected ears for middle ear effusion; type B, flat curve; and the operative findings (fluid found in the middle ear at the time of myringotomy) was recorded.
Results: The diagnostic accuracy and examination success rate of tympanometry; type B, flat curve; in predicting middle ear effusion was 71.4%. Moreover, the sensitivity, specificity, positive and negative predictive values were 97.2% , 57.3%, 55.3% and 97.5% respectively. Thus, the positive likelihood ratio was 2.3.
Conclusion: The accuracy rate of tympanometry in predicting middle ear effusion showed a fair validity for its exclusion. The use of pneumatic otoscopy and tympanometry together improves the accuracy of diagnosis.

Key words: Tympanometry, middle ear effusion, myringotomy.

الخلاصـــة
الأهداف: تهدف الدراسة الحالية إلى تقيم دور جهاز قياس ضغط الأذن في تشخيص انصباب الأذن الوسطى وذلك بمقارنة البيانات مع نتائج العمليات.
التصميم: دراسة وصفية مهتمة بدراسة ١٠٥ أذن عائدة إلى ٥٧ مريض شَخصتْ بجهاز قياس ضغط الأذن كانصباب الأذن الوسطى والتي خضعتْ إلى عملية بزل الأذن الوسطى مع زرع أو عدم زرع أنبوب التهوية.
موقع العمل: أجريت الدراسة في شعبة الأنف والأذن والحنجرة / مستشفى السلام التعليمي / موصل – العراق للفترة من نيسان/أبريل ٢٠٠٣ إلى تشرين الأول /سبتمبر ٢٠٠٤. فضلا عن أن قياس ضغط الأذن اجري في العيادة الخارجية/ مستشفى الجمهوري التعليمي.
الحالات: أجريت الدراسة على ١٠٥ أذنا عائدة إلى ٥٧ مريضا والتي شَخصتْ كانصباب الأذن الوسطى بواسطة جهاز قياس ضغط الأذن، منهم ٣٦ نكرا و ٢١ أنثى بمعدل ١:١،٧ . وكان متوسط العمر بمعدل ٦ سنة بمديات تراوحت بين ٣-١٢ سنة.
الطرائق المستعملة: تشمل البيانات التي حللت في الدراسة على العمر، الجنس ونتائج جهاز قياس ضغط الاذن. وتمت مقارنة البيانات بين جهاز قياس ضغط الأذن والنتيجة الإيجابية لعملية بزل الأذن الوسطى .
النتائج: بلغت دقة نجاح جهاز قياس ضغط الأذن في تشخيص تصبب الأذن الوسطى ٧١,٤%. فضلا عن أن الحساسية والخصوصية كانتا بنسبة ٩٧،٢% و ٥٧،٣% على التوالي.

الاستنتاج: يمكن الاعتماد بشكل نسبي على جهاز قياس ضغط الإذن في تشخيص انصباب الأذن الوسطى مع دقة أعلى في نفي هذا المرض. نوصي باستعمال الفحص بمنظار الأذن الهوائي سوية مع جهاز قياس ضغط الأذن للوصول إلى دقة أعلى في التشخيص.

الكلمات الدليلة: جهاز قياس ضغط الإذن, انصباب الأذن الوسطى, بزل الأذن الوسطى.

S ecretory otitis media is defined as the presence of effusion behind an intact eardrum without symptoms of acute infections. It is a common problem of infants and children 1 to 5 years old[1]. About 90% of children (80% of individual ears) have otitis media with effusion (OME) at some time before school age, most often between ages 6 months and 4 years. In the first year of life, more than 50% of children will experience OME, increasing to more than 60% by age 2 years. Many episodes resolve spontaneously within 3 months, but about 30% to 40% of children have recurrent OME and 5% to 10% of episodes may last 1 year or longer[2].

Most cases of secretory otitis media are asymptomatic and are discovered during child check up. The diagnosis is otoscopic confirmed by tympanometry[1].

Tympanometry is a test used to detect disorders of the middle air. Air pressure in the ear canal is varied to test the condition and mobility of the tympanic membrane. This test determines the functionality of the tympanic membrane by observing its response to waves of pressure and measuring the pressure of the middle ear[3].

Tympanometry aids assessment of the outer and middle ear system, including the Eustachian tube. It is often not recommended for infants younger than 7 months because their ear canal cartilage is so soft that misleading tympanometric results can occur[4].

Aims of the study: To evaluate the role of tympanometry; type B, flat curve; in predicting middle ear effusion by comparing the results with the operative findings (fluid found in the middle ear at the time of myringotomy).

The specific objectives of the study were:

1. To identify the age, sex and tympanometric results of patients with middle ear effusion.
2. To estimate the validity of tympanometry in diagnosing middle ear effusion (sensitivity, specificity, positive and negative predictive values).
3. To calculate the accuracy rate and examination success rate of tympanometry ;type B, flat curve; in predicting middle ear effusion).

PATIENTS AND METHODS

This study presents a descriptive analysis of 105 ears (57 patients) diagnosed by tympanometry as middle ear effusion that underwent myringotomy operation(with or without ventilation tube insertion).

These procedures were performed in the Department of ENT- Al-Salam Teaching Hospital/Mosul for the period from April 2003 to September 2004.

The patients were collected from the Outpatient Clinic of Al-Salam Teaching Hospital and the private clinics during the period of the study.

Otitis media with effusion is suspected because of hearing loss, unexpected educational delay and behavioral problems. Its otoscopic diagnosis includes loss of light reflex, possibly with a fluid level or bubbles visible through the drum.

All clinically suspected patients underwent tympanometry in the Outpatient Clinic of Al-Jamhoori Teaching Hospital. The findings of tympanometry were classified into three curves namely; normal (type A), middle ear effusion (type B, flat) or negative pressure (type C).

Myringotomy was performed at Al-Salam Teaching Hospital under general anaesthesia through an anteroinferior radial incision. A comparison between the tympanometric diagnosis of middle ear effusion; type B, flat curve; and the operative findings (fluid found in the middle ear at the time of myringotomy) was recorded.

The following data were further recorded:
1. Age and sex of the patient.
2. Accuracy rate, sensitivity, specificity, positive and negative predictive values of tympanometry in predicting middle ear effusion.

Statistical analysis was performed using the Z-proportion test.

RESULTS

The mean age of the patients was 6 years with a range of 3-12 years. The commonest age group was in the 5th-6th years of life(Fig. 1). The study included 36 male patients (63.2%) and 21 females (36.8%) with a ratio of 1.7:1. This difference was statistically significant (Z=2.81, P<0.01).

Table (1) shows that the most frequent curve recorded was type B, flat curve

(61.9%). Moreover, tympanic membrane congestion was bilateral in 51 patients (89.4%) and unilateral in 6 patients (10.6%). This difference is statistically significant (Z= 8.43, P<0.001).

The overall diagnostic accuracy and examination success rate of type B, flat curve in predicting middle ear effusion was 71.4%. The sensitivity, specificity, positive and negative predictive values were 97.2%, 57.3%, 55.3% and 97.5% respectively[5]. The positive likelihood ratio was 2.3 (Table 2).
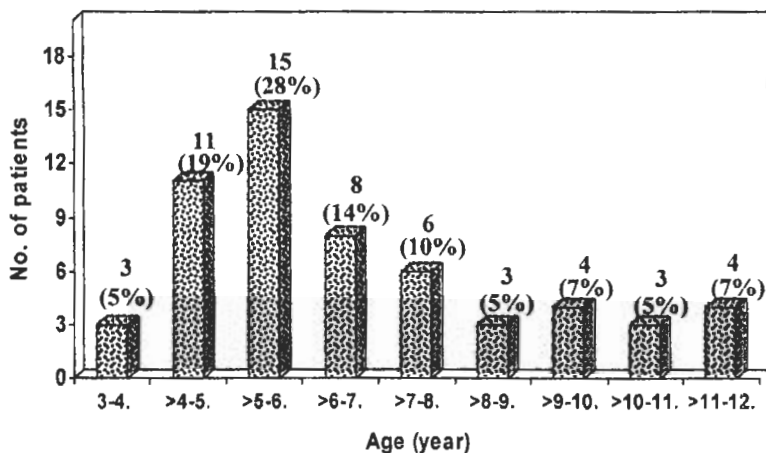

Figure (1): *Age distribution of the patients.*

Table (1): *Tympanometry Curves.*

| Type of curve | No.(%) | Operative finding | |
		+ve(%)	-ve(%)
Type A	24(22.9%)	---	24(100%)
Type B	65(61.9%)	36(55.3%)	29(44.7%)
Type C	16(15.2%)	1(6.3%)	15(93.7%)
Total	105(100%)	37(35.2%)	68(64.8%)

Table (2): *Validity tests.*

| | | Operative findings | | Total |
		(+ve)	,ve)	
Tympanometry	(+ve) Type B	a = 36	b = 29	a+b 65
	,ve) Type A or C	c = 1	d = 39	c+d 40
	Total	a+c 37	b+d 68	a+b+c+d 105

Accuracy rate = $\frac{a+d}{a+b+c+d} = \frac{75}{105} \times 100 = [71.4\%]$

Positive likelihood ratio = $\frac{a}{a+c} / [\frac{b}{b+d}] = \frac{36}{37} / [\frac{29}{68}] = 2.3$

DISCUSSION

Otitis media in children continues to be a major challenge for health care providers. Distinguishing a cute o titis m edia f rom o titis media with effusion is clinically important because antibiotics are seldom indicated for the latter condition. All children with chronic middle ear effusion should have audiological evaluation. Tympanometry and acoustic reflectometry can be useful adjunctive t ools to c onfirm t he p resence of fluid in the middle ear [7,8].

The average age of the patients studied was 6 years with a range of 3-12 years. The study included 63.2% males and 36.8% were females. Similarly, Sankovic and Dergenc (1996)[9] reported that the age of their patients ranged from 9 months to 12 years. In other words, middle ear effusion is common during the most intensive period of language d evelopment, w hich is a concern given the risk of hearing loss associated with it[10].

The study revealed that the diagnostic accuracy and examination success rate of tympanometry; type B, flat curve; in predicting middle ear effusion was 71.4%. The sensitivity and specificity were 97.2% and 57.3% respectively. These results indicate that the test is showing a high sensitivity and low specificity rates. A sensitive test is more useful in detecting the disease in screening processes and minimizing false negative diagnoses. Similarly, Babonis (1991)[11] stated that tympanometry detects the presence or absence of middle ear effusion in 73% of ears with a sensitivity and specificity of 90% and 54% respectively. While, Lous (2000)[12] reported that a f lat t ympanogram (type B) predicts a middle ear effusion in 90% of cases, thus, it is recommended as a diagnostic modality for general practitioners.

It can be concluded that tympanometry is well established as a means of assessing the presence of fluid in the middle ear. The type B tympanogram is usually considered a unique entity[13].

The Canadian Medical Association Journal (2001) stated that the sensitivity and specificity of tympanometry were over 80% i n p redicting fluid f ound in t he m iddle ear at s urgery, w hereas t he s ensitivity a nd specificity of pneumatic otoscopy were 89 and 80% respectively [10]. In comparison, Olusanya (2001)[14] reported that the sensitivity and specificity of tympanometry were 52% and 84% respectively.

The positive and negative predictive values in our study were 55.3% and 97.5% respectively. Similarly, Butler and Macmillan[15] reported that the positive predictive value of an abnormal (type B, flat) tympanogram is between 49% and 66% that is, half of ears with abnormal tympanograms may have otitis media with effusion. The negative predictive value of this test is more informative because of high s ensitivity rate s o t he m ajority o f e ars with normal tympanograms (type A curve) will, in fact, be normal[16]. Palmu (2001)[17] reported that negative pressure tympanogram (type C) is a poor indicator for the presence of middle ear fluid. If otitis media is diagnosed with negative tympanometric peak pressure, negative middle ear bacterial culture for the main pathogens is highly probable.

The positive likelihood ratio in our study was 2.3. Values of the likelihood ratio greater than one correspond to situations in which persons affected with the disease of interest are more likely to have a positive test result than unaffected persons[6].

Al-Hayali and A.Muttalib (2003)[18] reported that the accuracy rate, sensitivity and specificity of clinical diagnosis in predicting m iddle ear effusion were 60.4%, 96% and 18% respectively. Because the strength of tympanometry (it provides a quantitative measure of tympanic membrane mobility) and pneumatic otoscopy (many abnormalities of the ear drum and ear canal that can skew the results of tympanometry are visualized); using both pneumatic otoscopy and tympanometry together improve the accuracy of diagnosis[16].

The possible explanation to the variable results of tympanometry regarding its sensitivity and specificity may b e attributed to the following factors:

1. Waiting period till myringotomy done.
2. Recumbency may lead to fluid displacement to the epitympanum and mastoid or through Eustachian tube.
3. Anaesthetic gases: when inhalant anaesthesia with assisted ventilation is used, there is a significant increase of middle ear pressure due to use of nitrous oxide; this pressure increment can evacuate the fluid from the middle ear via the Eustachian tube[19].
4. Technical causes: these are either related to examiner fault or anatomical causes which may give type B curve and these include:
   - Hard packed cerumen.
   - Perforation of the tympanic membrane.
   - Patent ventilation tube.
   - Non air tight seal probe.
   - Probe facing the canal wall.
5. Recurrent episodes of middle ear effusion appear to alter the acoustic immittance characteristics of the middle ear even when

middle ear effusion is absent in these cases[20].

Conclusion: It can be concluded from these data; of moderate accuracy rate, high sensitivity and negative predictive value with a relatively low specificity and positive predictive value; that tympanometry (type B, flat curve) is a fair predictor of middle ear effusion with better results in exclusion of the effusion (type A and type C curves)'

The study recommends the use of both pneumatic otoscopy (many abnormalities of the ear drum are visualized) and tympanometry (it provides a quantitative measure of tympanic membrane mobility) to improve the accuracy of diagnosis.

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