

Significance of Tympanometry in Children with Acute Otitis Media (AOM): a Prospective Study

أهمية قياس ضغط الأذن الوسطى عند الأطفال المصابين بالتهاب الأذن الوسطى
الحاد: دراسة استطلاعية

Dr. Firas M. Hassan ¹

Department of surgery/ College of Medicine/ University of Kufa;

Lecturer, FIBMS, FAVORL-HNS

e-mail: firasm.hasan@uokufa.edu.iq

ABSTRACT:

Introduction: Tympanometry is the most commonly used aspect of impedance audiometry and is particularly useful in evaluating children with otitis media with effusion. Although its application in diagnosis of AOM is not routinely performed, this study was carried out to demonstrate the usefulness of performing the tympanometry test in children with AOM and to regard it as a prognostic index in accordance to its results by identifying which of those patients were at a great risk of treatment failure.

Aim of the study: To analyze the prognostic significance of tympanometry by assessing its ability to identify the ratio of children with AOM who are at great risk of treatment failure.

Patients and methods: This is a prospective study of 80 pediatric patients with recent attacks of acute otitis media attending the ENT clinic of Al-Sader medical city in Najaf during one year period from 1-6-2014 to 1-6-2015. The diagnosis of the AOM was done based on the presence of the clinical signs and symptoms of this disease. The patients had been sent for tympanometry and the results of tympanogram had been documented. All the patients treated in regard of the AOM by giving them antibiotics in the form of oral suspension for 14 days and their signs and symptoms assessed again at the end of treatment period.

Data analysis: The statistical calculations were carried out using chi-square test. The *p* value <0.05 was considered statistically significant.

Results: 80 patients (115 infected ears), their age ranged from 2 to 12 years with mean age of 6.25. 53 (66.25%) were males and 27 (33.75%) were females with M:F is 1.96:1. Tympanometric results of the total 115 infected ears with AOM revealed that type A tympanogram appeared in 57 (49.6%) of the ears and type B appeared in 35 (30.4%), while 23 (20%) of the ears had type C graph. After treatment with antibiotics for 14 days, 53 of the ears who had type A tympanogram from the start showed a complete recovery. For those ears with type B tympanometric results, 22 ears showed a complete cure and of those 23 ears with type C tympanogram, 16 had complete cure.

Conclusion: By observing the difference in treatment duration and recovery period among the different types of tympanometry in children suffering from AOM, it is concluded that tympanometry of children with AOM is able to provide a prognostic information regarding treatment failure.

Recommendations: It is recommended to perform the tympanometry routinely in all children suffering from an attack of AOM as its type will predict the duration of antibiotics treatment and this will avoid the treatment failure resulting from early discontinuation of antibiotics in high risk children with abnormal tympanometric patterns.

Key words: acute otitis media, children, tympanometry

الخلاصة

المقدمة: إن قياس ضغط الأذن الوسطى باستخدام التيمبانومتري له أهمية خاصة في تشخيص الأطفال الذين يعانون من التهاب الأذن الوسطى مع تجمع السوائل خلف طبلة الأذن. على الرغم من أن تطبيقه في تشخيص التهاب الأذن الوسطى الحاد لا يتم بشكل روتيني، أجريت هذه الدراسة لإثبات فائدة إجراء الفحص عند الأطفال الذين يعانون من هذه الالتهابات واعتبار نتائجه مؤشرا لتحديد أي من المرضى معرضين أكثر من غيرهم لخطر فشل العلاج.

الهدف من الدراسة: تحليل أهمية قياس ضغط الأذن الوسطى للأطفال الذين يعانون من التهاب الأذن الوسطى الحاد و تقييم قدرته على تحديد أي من هؤلاء الأطفال هم في خطر كبير من فشل العلاج.

المنهجية: دراسة استطلاعية أجريت في عيادة الأنف والأذن والحنجرة في مدينة الصدر الطبية في النجف الأشرف خلال سنة واحدة من 1-6-2014 إلى 1-6-2015. اشتملت الدراسة على 80 طفلا مريضا كانوا يعانون من التهاب الأذن الوسطى الحاد وقد تم تشخيص الالتهاب في الأذن على أساس وجود العلامات والأعراض السريرية لهذا المرض. تم إرسال المرضى لقياس ضغط الأذن الوسطى، وقد تم توثيق نتائج الفحص. عولجوا جميع المرضى من خلال منحهم المضادات الحيوية عن طريق الفم لمدة 14 يوما وتم تقييم علامات وأعراض المرض مرة أخرى في نهاية فترة العلاج.

النتائج: 80 مريضا (115 أذن مصابة)، تراوحت أعمارهم بين السنتان و12 سنة مع متوسط عمر 6.25. عدد الذكور كانوا 53 (66.25%) طفلا و كان ما مجموعه 27 (33.75%) طفلا منهم من الإناث. أظهرت نتائج قياس ضغط الأذن الوسطى من مجموع 115 أذن مصابه بالتهاب الأذن الوسطى الحاد بان نوع أ كان في 57 (49.6%) من الحالات ونوع ب ظهر في 35 (30.4%)، في حين أنه في 23 (20%) من الحالات كان نوع ج هو الحاضر. بعد العلاج بالمضادات الحيوية لمدة 14 يوما، 53 من الذين كان لديهم نوع أ من البداية أظهروا الشفاء الكامل. بالنسبة لأولئك الذين ظهرت لديهم نوع ب فان 22 منهم حصلوا على الشفاء التام، وبالنسبة للحالات التي كانت لديها نوع ج فقد ظهر الشفاء التام في 16 حالة.

الاستنتاج: من خلال مراقبة الفرق في مدة العلاج وفترة النقاهة بين الأنواع المختلفة من قياس ضغط الأذن الوسطى عند الأطفال الذين يعانون من التهاب الأذن الوسطى الحاد، خلص إلى أن إجراء هذا الفحص قادر على توفير مؤشرا لتحديد أي من المرضى معرضين أكثر من غيرهم لخطر فشل العلاج.

التوصيات: من المستحسن إجراء فحص التيمبانومتري لقياس ضغط الأذن الوسطى و بشكل روتيني لجميع الأطفال الذين يعانون من التهاب الأذن الوسطى الحاد. الهدف من ذلك هو لتجنب فشل العلاج الناتج عن التوقف المبكر في استخدام المضادات الحيوية لدى الأطفال الذين يعانون من نتائج غير طبيعية الأنماط فيما يخص فحص ضغط الأذن الوسطى.

مفردات البحث: التهاب الأذن الوسطى الحاد، الأطفال، قياس ضغط الأذن الوسطى

INTRODUCTION:

Acute otitis media (AOM) may be defined clinicopathologically as inflammation of the middle ear cleft of rapid onset and infective origin, associated with a middle ear effusion and a varied collection of clinical symptoms and signs. It is synonymous with acute suppurative otitis media. It normally develops behind an intact tympanic membrane, but may include acute infections arising in the presence of ventilation tubes or existing tympanic membrane perforation. The literature supports four broadly defined subgroups of AOM,⁽¹⁾

1. Sporadic episodes occurring as infrequent isolated events, typically occurring with upper respiratory tract infections.
2. Resistant AOM: persistence of symptoms and signs of middle ear infection beyond three to five days of antibiotic treatment.
3. Persistent AOM: persistence or recurrence of symptoms and signs of AOM within six days of finishing a course of antibiotics.
4. Recurrent AOM: either three or more episodes of AOM occurring within a six-month period, or at least four or six episodes within a 12.

Grading of the severity of an episode has been attempted and has merit both clinically and for research. Pyrexia from 37.5-39°C, vomiting and severity of otalgia have been used.⁽²⁾

Tympanometry is the continuous recording of middle ear impedance as air pressure in the ear canal is systematically increased or decreased.

The technique is a sensitive measure of tympanic membrane integrity and middle ear function . Compliance (the reciprocal of stiffness) of the middle ear and the dominant component of immittance, is the vertical dimension of a tympanogram. Tympanometry is popular clinically because it requires minimal technical skill and less than a minute to perform. Because immittance measurement is an electrophysiologic (versus behavioral) method, it does not depend on cooperation of the patient.⁽³⁾ Tympanometric patterns permit differentiation among and classification of middle ear disorders. In 1970, James Jerger described what has become the most clinically widespread approach for describing tympanograms. There are three general tympanogram types: A, B, and C. The normal, or type A, tympanogram has a distinct peak in compliance within +50 to–100 mm of water pressure (decapascals) in the ear canal.⁽⁴⁾

To be classified as normal, the location of the compliance peak on the pressure dimension and the height of the peak must be within the normal range. With a type B tympanogram, there is no peak in compliance but, rather, a flat pattern with little or even no apparent change in compliance as a function of pressure in the ear canal. This pattern is most often associated with fluid within the middle ear space, although other middle ear lesions may give rise to a type B tympanogram as well. Type C tympanograms also have a distinct peak in compliance (as with the type A), but the peak is within the negative pressure region beyond –100 mm H₂O (or dkPa). This pattern is usually found in patients with Eustachian tube dysfunction and inadequate ventilation of the middle ear space and often precedes the type B tympanogram in the development of otitis media.⁽⁵⁾

AIM OF STUDY:

To analyze the prognostic significance of tympanometry by assessing its ability to identify the ratio of children with AOM who are at great risk of treatment failure.

PATIENTS AND METHODS:

This is a prospective study of 80 patients aged 2-12 years old with recent attacks of acute otitis media attending the ENT clinic of Al-Sader medical city in Najaf during one year period from 1-6-2014 to 1-6-2015. For each patient participated in the study, full history had been taken from the patients' parents and complete ENT examination had been done. The diagnosis of the AOM was done based on the presence of the clinical signs and symptoms of this disease. These included the history of preceding upper respiratory tract infection with the recent development of fever, night crying, ear ache and any ear discharge that appeared during the course of the illness. Then the diagnosis was confirmed by the otoscopic findings of tympanic membrane redness. Patients with the following findings had been excluded from the study,

- 1- Those with tympanic membrane perforation
- 2- Those with a concomitant adenoid hypertrophy or recurrent tonsillar infection
- 3- Patients with a history of previous otologic surgery
- 4- Those with craniofacial anomalies
- 5- Patients with genetic diseases

For the total 80 patients, 45 were complaining of unilateral AOM, while the remaining 35 patients had bilateral disease with the total of 115 infected ears enrolled in the study. After confirming the diagnosis, the patients had been sent for tympanometry and the results of tympanogram had been documented. The results were either type A graph with a normal pressure curve and peaked between +50 and -100 mm H₂O, type B graph with a flat shape curve, or type C graph with a negative pressure peaked shaped curve, <-100 mm H₂O. All the patients treated in regard of the AOM by giving them antibiotics in the form of oral suspension for 14 days. This treatment period was recommended in this study in order to give the patients the adequate dose of antibiotics and to avoid any failures resulting from an early discontinuation of the treatment. At the end of this treatment period, the patients' signs and symptoms had been assessed again and documented.

Data analysis: The statistical calculations were carried out using chi-square test. The *p* value <0.05 was considered statistically significant.

RUSULTS:

A total of 80 patients had been included in the study. Their age ranged from 2 to 12 years with mean age of 6.25. Their gender distribution showed that 53 (66.25%) were males and 27(33.75%) were females with M:F is 1.96:1.

Tympanometric results of the total 115 infected ears with AOM revealed that type A tympanograph appeared in 57 (49.6%) of the ears and type B appeared in 35(30.4%), while 23(20%) of the ears had type C graph.

After treatment with antibiotics for 14 days, 53 of the ears who had type A tympanogram from the start showed a complete recovery by resolution of the symptoms and normalization of tympanic membrane on otoscopy. The remaining four

continued to have otalgia with persistent redness of the tympanic membrane on examination and the patients were advised to be on antibiotics for further 14 days. For those ears with type B tympanometric results, 22 ears showed a complete cure with disappearance of the signs and symptoms while the remaining 13 ears continued to complains with tympanic membrane redness on otoscopy and the patients continued the treatment course for another 14 days. Of those 23 ears with type C tymanogram , 16 had complete cure while the patients with the remaining 7 ears continued the treatment for further 14 days as they did not show any improvement in the immediate treatment period, table (1)

Ears with AOM	Type of tympanometry			Total(%)
	A(%)	B(%)	C(%)	
No. of cured	53(93)	22(62.85)	16(69.6)	91(79)
No. of non cured	4(7)	13(37.15)	7(30.4)	24(21)
Total	57(100)	35(100)	23(100)	115(100)

DISCUSSION:

Tympanometry is the most commonly used aspect of impedance audiometry and is particularly useful in evaluating children with otitis media with effusion.⁽⁶⁾

Although its application in diagnosis of AOM is not routinely performed, this study was carried out to demonstrate the usefulness of performing the tympanometry test in children with AOM and to regard it as a prognostic index in accordance to its results by identifying which of those patients were at a great risk of treatment failure.

Of the total 80 patients (115 ears) with AOM, 91(79%) had complete cure at the end of two weeks antibiotics treatment while 24(21%) continued to complain and needed an elongated treatment period. For tympanometric analysis, type A tympanometry presented in 57 (49.6%) of them. Two weeks follow up, after giving them antibiotics to treat their acute middle ear infections, revealed that 93% of them had complete recovery and 7% persisted to complain and advised to continue the antibiotics treatment for further two weeks. For the 35 (30.4%) of the ears who had type B tympanometry at the time of presentation, 62.85% had complete recovery while an obvious percentage of 37.15% would continue to complain from the signs and symptoms of AOM and the patients advised to be on treatment for additional two weeks. In regards to those 23 (20%) ears with type C tympanometry, 69.6% had complete cure after two weeks treatment and remaining 30.4% were complaining and put on further treatment period. It appeared that those patients with AOM and type A tympanometry needed less duration of antibiotics treatment than those with type B or C. Statistical analysis of these variables using chi-square test showed that there was a significant difference among these groups with *p* value = 0.001. Although; the difference in recovery period

among those children with AOM who had type B and type C tympanometry was statistically not significant , p value = 0.6. The interpretation of these finding is that those patients with type A tympanometry had normal middle ear pressure and functioning Eustachian tube. In contrary, those patients with type B or type C tympanometry had middle ear effusion or Eustachian

tube dysfunction respectively and these will be regarded as a risk factors of treatment failures if the patients suffered from acute middle ear infections.

In comparing this study with other studies, Iino et al⁽⁷⁾ in 1993 carried out a study to determine the clinical course of acute otitis media in children and to analyze the risk factors that lead to persistent effusion. They showed that the most significant prognostic factor for delay recovery of an attack of AOM was a tympanogram type B or C.

In Japan in 1994, Sakaguchi et al⁽⁸⁾ had studied the use of tympanometry to investigate the potential changes in the middle ears during and after unilateral acute otitis media (AOM) in Japanese children. They observed that ears with type B changes at presentation showed a significantly slower recovery of middle ear ventilation than did those with either type A or type C.

In 1994, Steven et al⁽⁹⁾ assess the ability of tympanometry to detect the children with AOM who are at higher incidence of treatment failure. They observed that initial treatment success was similar for all tympanometric types and the rates of relapse , reinfection and persistant otoscopic findings did not differ significantly between the groups. They concluded that tympanometry of children with AOM is unable to provide prognostic information regarding treatment failure.

Babonis et al⁽¹⁰⁾ in 1994 assessed The presence of middle ear effusion (MEE) following acute otitis media (AOM) by impedance tympanometry and acoustic reflectometry. Their descriptive study examined serial measurements by tympanometry and reflectometry in children with clinical AOM at the time of diagnosis, 3 to 5 days later, and at final follow-up 12 to 15 days after diagnosis. They concluded that initial tympanometry and reflectometry add to the cost of AOM diagnosis without clear benefit for the individual patient. In 2002, Palmu et al⁽¹¹⁾ studied the significance of tympanometry in identification of children with high risk of development or prolongation of otitis media. They observed that type C tympanometry was found to predict the development of otitis media when observed during upper respiratory infection with no concomitant ear disease. Otitis media developed in 40% of children with negative pressure tympanometric peak compared with 20% of children without negative pressure. They concluded that profound negative tympanometric peak pressure is a significant marker of increased risk for development of acute otitis media after an attack of upper respiratory tract infection. Saeed et al⁽¹²⁾ in 2004 compared otoscopic, and tympanometric findings in AOM including cases of AOM without effusion. They found that there has been no direct comparison of otoscopic and tympanometric findings and tympanometry is not necessary in the diagnosis of acute otitis media. In another study carried out by Renko et al⁽¹³⁾ in 2006, they used the tympanometry to monitor the outcomes in patient with AOM treated by antimicrobials for 14 days. They concluded that normal tympanograms were obtained after a median time of 7.5 days and the choice of antimicrobials did not influence the duration of treatment.

In 2008, Revai et al⁽¹⁴⁾ use the tympanometry to address the middle ear status and the tympanometric findings during the first week of upper respiratory infection were recorded. Their study concluded that patients with Eustachian tube dysfunction and middle ear abnormality during upper respiratory tract infection are more prone to develop AOM than those with normal tympanometry.

Recently in 2015, Kostić et al⁽¹⁵⁾ investigate the frequency and duration of middle ear effusion in children following an episode of acute otitis media. They recommended to perform follow up tympanometry in children recovering from

acute otitis media (AOM) and they found that children with Type B tympanogram during the attack of AOM are very likely to have a conductive hearing loss 3 months following the onset of the disease.

CONCLUSION:

By observing the difference in treatment duration and recovery period among the different types of tympanometry in children suffering from AOM, it is concluded that tympanometry of children with AOM is able to provide a prognostic information regarding treatment failure.

RECOMMENDATION:

It has been recommended to perform the tympanometry routinely in all children suffering from an attack of AOM as its type will predict the duration of antibiotics treatment and this will avoid the treatment failure resulting from early discontinuation of antibiotics in high risk children with abnormal tympanometric patterns.

REFERENCES :

1. Peter Rea and John Graham, Acute otitis media in children, Scott-Brown's Otorhinolaryngology , Head and Neck Surgery , volume 1, 7th edition. Michael Gleeson. 2008, 73: 912-3.
2. Rudolf Probst, otitis media, Basic Otolaryngology, a Step by Step Learning Guide, Thieme. 2006, 11.3: 238
3. Robert W. Sweetow, and Jennifer Henderson Sabes, Audiologic Testing , Current Diagnosis and Treatment , otolaryngology head and neck surgery, 2nd edition. Anil K. Lalwani. 2008 , 45: 600-2.
4. Brad A. Stach, Audiologic Evaluation of Otologic/Neuro-otologic Disease, Glasscock-Shambaugh Surgery of the Ear, 5th edition. Michael E. Glasscock & Aina Julianna Gulya. 2003,8: 168.
5. James W. Hall and M. Samantha Lewis. Diagnostic Audiology, Hearing Aids, and Habilitation Options, Ballenger's Otorhinolaryngology, Head and Neck Surgery, 16th edition, James B. Snow Jr and John Jacob Ballenger, 2003, 5: 138-9.
6. N.J.Ronald, R.D.R.McRea, and A.W.McCombe. Impedance Audiometry , Key Topics in Otolaryngology. 2nd editin, 2001; 129.
7. Iino Y, Nakamura Y, Koizumi T, Toriyama M, Prognostic factors for persistent middle ear effusion after acute otitis media in children. Acta Otolaryngol. 1993 Nov;113(6):761-5.
8. Sakaguchi M, Taguchi K, Ishiyama T, Netsu K, Katsuno S, Tympanometric changes following acute otitis media in Japanese children. Eur Arch Otorhinolaryngol. 1994;251(2):113-6.
9. Steven M. Green, Steven G. Rothrock, Timothy P. Nesper, Christopher B. Hummel, Outcome of AOM with Abnormal Tympanometric Patterns in Children. Academic Emergency Medicine. 1994 Aug; 1(4):346-53
10. Babonis T, Weir MR, Kelly PC, Krober MS, Progression of tympanometry and acoustic reflectometry. Findings in children with acute otitis media. Clin Pediatr (Phila). 1994 Oct;33(10):593-600.
11. Palmu A, Puhakka H, Rahko T, Takala A, Kilpi T, Predicting the development and outcome of otitis media by tympanometry. Int J Pediatr Otorhinolaryngol. 2002 Feb 1;62(2):135-42.
12. Saeed K, Coglianese CL, McCormick DP, Chonmaitree T. Oscopic and tympanometric findings in acute otitis media yielding dry tap at tympanocentesis. Pediatr Infect Dis J. 2004 Nov;23(11):1030-4.
13. Renko M, Kontiokari T, Jounio-Ervasti K, Rantala H, Uhari M, Disappearance of middle ear effusion in acute otitis media monitored daily with tympanometry. Acta Paediatr. 2006 Mar;95(3):359-63.
14. Revai K, Patel JA, Grady JJ, Chonmaitree T., Tympanometric findings in young children during upper respiratory tract infections with and without acute otitis media. Pediatr Infect Dis J. 2008 Apr;27(4):292-5.
15. Kostić M, Ribarić Jankes K, Trotić R, Ries M, Ledić B, Bedeković V, Clinical and audiological findings in children with acute otitis media. Acta Otolaryngol. 2015 Jul;135(7):645-50