Otoscopic and audiological findings in patients submitted for myringotomy

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Abstract

Otitis media with effusion (OME) is common pediatric ENTproblem, which may cause hearing impairmentand poor school performance. Myringotomy, which may beperformed to treat OME, may be the second most commonly performed pediatric operation. The study aimed to study otoscopic and audiometric findings in patients planned to have myringotomy to treat OME, and compare these findings to the operative findings (dry tab, thin suffusion, thick effusion). This is a prospective study in Department of Otolaryngology / Hospital of Specialized Surgeries– Medical City (Baghdad).Thirtyone patients were admitted to the ENT department to do myringotomy because of OMEthat did not resolve after watchfull waiting or after failed medical treatment.The day before surgery otoscopy was done and new pure tone audiometryand tympanometry obtained for all patients.There were 31 patients,with a mean age (8.3 ± 3.4) yearsand the range was (3-15) years.Among them there were 14 males (45.2%) and 17 females (54.8%).Otoscopy has a sensitivity 90.2%, but not specific. Rinne test has sensitivity 79.6%, specificity 14.3%. Tympanometry give sensitivity 68.6%, specificity 18.2%.Pneumatic otoscopy is an accurate diagnostic tool for detection of OME if performed by well-trained otolaryngologist.It does not require complicated electronic machines or software, it is

atraumatic, non-invasive and repeatable . it does not require cooperation from the patient.It has sensitivity 90.2%, specificity 45.5%, and accuracy 82.3%.

Keywords: otoscopy; otitis media; myringotomy

Introduction

The human ear consist of three parts: the external ear, the middle ear, and the inner ear.The inner ear is beyond the scope of this thesis. We will discuss shortly the 1external ear, and we discuss indetail the middle ear.The *auricle* (or *pinna*) projects at a variable angle from the side of the head and has some function in collecting sound. The body of theauricle formed from elastic cartilage extends 8 mm down theear canal to form its lateral third.The externalauditory canal extends fromtheauricle to the tympanic membrane and is 2.4 cm long. The supporting framework of the canal wall is cartilage in the lateral one-third and bone in the medial two-thirds.At the outer limits of the ear canal are some short hairsthat project towards the opening of the canal. In this region areclusters of *ceruminous*and *sebaceous* glands.The middleear cleft consists of the *tympanic cavity*,the*Eustachian tube(ET)* and *the mastoid air cell* system. The tympaniccavity is an irregular, air-filled space within the temporal bone between the tympanic membrane (TM) laterally and the osseous labyrinth medially. It contains theauditoryossiclesand their tendonsthat attach them to themiddle ear muscles. Other structures, including the tympanic segment of the facial nerve, run along its walls to pass through the cavity [1].

The Eustachian tube is a dynamic channel that links the middle ear with the nasopharynx. In adults, it is36 mm in length. It runs downwards from the middle ear at 45° and is turned forwards and medially. Thetube consist of two unequal cones, connected at their apices. The lateral third is bony and arises from the anterior wall of the tympanic cavity. This joins medial cartilaginous part, which makes up two-thirds of the tubal length, just after its narrowest portion, called the *isthmus* . The tube is lined with respiratory mucosa containing goblet cells and mucous glands, having a carpet of ciliated epithelium on its floor. At its nasopharyngeal end, the mucosa is truly respiratory; but in passing along the tube towards the middle ear, the number of goblet cells and glands decreases, and the ciliary carpet becomes less profuse [2-4].

The normal auditory system provides humans with exquisitely sensitive binaural hearing for sound perciption and speech understanding; it is able to decipher complicated acoustic

signals with enormous dynamic and frequency ranges and process them inway that is understandable to us. As the acoustic signal enters the ear, it is first transformed into a mechanical signal by the middle ear, which plays a crucial role in impedance matching[5-11]. This mechanical signal is transmitted to the inner ear, where its frequency components are analyzed by the basilar membrane. The signal, which is embedded in the traveling wave of the basilar membrane, is transformed again into electrochemical form by the hair cells. This signal is propagatd by the afferent auditory neurons as action potentials to auditory brainstem, midbrain, thalamus, and auditory cortex for further processing. In addition to the afferent pathway, the auditory system has two major efferent pathways that prevent acoustic overstimulation and enhance speech discrimination in background noise [12-17].

The external ear has two main influence on the incoming sound. First, it increases the pressure at the tympanic membrane in a frequency sensitive way. Second, it increases the pressure in a way that depends on the direction of the sound source, and can therefore be used as an aid to sound localization [18].

The middle ear couples sound energy to the cochlea. As well as providing physical protection for the cochlea, the middle ear serves as an acoustic transformer to match the impedance of the air to the much higher impedance of the cochlear fluids. The middle ear apparatus also serve to couple sound preferentially to only one window of the cochlea, thus producing a differential pressure between the windows, required for the movement of the cochlear fluids [17].

As a sound stimulus enters the EAC, it causes the tympanic membrane to vibrate. The malleus vibrates in response to the motion of the tympanic membrane. This cause the entire ossicular chain to vibrate, resulting in sound transmission to the inner ear via the stapes footplate. This pathway of sound transmission is referred to as *ossicular coupling*. The ossicular chain vibrates along an axis that projects through the head of the malleus and the body of the incus in an anterior-to-posterior direction. The stapes transmits the output of the middle ear into the inner ear through the oval window.

Because the inner ear is fluid-filled, if the sound stimulus strikes the inner ear fluid directly, most of the acoustic energy is deflected, as the impedance of fluid is much greater than the impedance of air. The pathway of sound transmission to the inner ear in

the absence of the ossicular system is referred to as *acoustic coupling*. The difference between ossicular coupling and acoustic coupling is 60 dB, which is the maximal amount of hearing loss expected in patients with ossicular discontinuity.The middle ear plays an important role in the process of "impedance matching" between the air-filled middle ear and the fluid-filled inner ear, allowing for efficient sound transmission. The most important factor in the middle ear's impedance matching capability comes from the "area ratio" between the tympanic membrane and the stapes footplate. The human tympanic membrane has a surface area 20 times larger than the stapes footplate (69 vs. 3.4 mm^2). If all the force applied to the tympanic membrane were to be transferred to the stapes footplate, the force per unit area would be 20 times larger (26 dB) on the footplate than on the tympanic membrane [5].

A second mechanism for impedance matching is called the *lever ratio,* which refers to the difference in length of the manubrium of the malleus and the long process of the incus. Because the manubrium is slightly longer than the long process of the incus, a small force applied to the long arm of the lever (manubrium) results in a larger force on the short arm of the lever (incus long process). In humans, the lever ratio is about 1.31 : 1 (2.3 dB). The combined effect of the area ratio and the lever ratio give the middle ear output a 28-dB gain theoretically. In reality, the middle ear sound pressure gain is only about 20 dB; this is mostly due to the fact that the tympanc membrane does not move as a rigid diaphragm. At higher frequencies, it vibrates in a complex manner, with multiple areas that vibrate differently. The effective area of the tympanic membrane involved with impedance matching is smaller than its total area. Nevertheless, the 20-dB middle ear sound pressure gain assists sound transmission from the air-filled middle ear into the fluid-filled inner ear [29].

The ET has 3 physiologic functions with respect to the middle ear :

(a) pressure regulation (ventilation) of the middle ear to equilibrate gas pressure in the middle ear with atmospheric pressure;

(b) protection from nasopharyngeal sound pressure and secretions; and

(c) clearance of secretions produced within the middle ear into the nasopharynx [31].

About 1 mL of air or gas may be absorbed from the middle ear in 24 hours. The mastoid cell system is thought to function as a gas reservoir for the middle ear [32].Slow-motion videoendoscopy has revealed four steps in tubal opening:

(1) palatal elevation with medial movement of the lateral pharyngeal wall and medial rotation of the medial lamina (initiation of opening of the distal cartilaginous tube presumably by the levatorvelipalatni),

(2) lateral movement of the lateral wall with dilation of the orifice laterally and vertically,

(3) propagation of dilation of the tubal lumen from distal to proximal by the tensor veli palatini/dilator tubea, and

(4) opening of the proximal cartilaginous tube adjacent to the junctional region with formation of a round to crescent-shaped lumen. During this event, the tube remains open for 0.3 to 0.5 second, but is open much longer during yawning. In normal individuals, the ET fully opens once or twice hourly [20-23].

Clearance of the middle ear cleft depends on programmed movement of the mucous blanket out of the eustachian tube. The middle ear mucosa and respiratory epithelium of the tube are covered with cilia that transport the mucous blanket from the tympanic orifice of the tube toward the nasopharynx. The tympanic opening of the tube lies above the level of the floor of the hypotympanum. Tube transport is an active process that is not gravity dependent. Material instilled through tympanic membrane perforations in humans and experimentally placed in the middle ear cleft of animals is actively cleared into the nasopharynx [23].

The clinical utility of ET function tests is currently limited. None are uniformly able to determine the adequacy of tubal function in candidates for surgical closure of a tympanic membrane perforation or to assess the risk of otitis media in candidates for myringotomy tube placement.

Tubal function tests are of two types:tests that measure passage of air through the tube, andtests that measure active muscular opening of the tube.

Tympanometry is an adjunct test that determine the flow of acoustic energy through the middle ear system (immitance testing) and indirectly measures ET function by

determining the relative middle ear pressure. Tympanometry can be used during tests of tubal function to determine objectively middle ear pressure changes [21-23].

Otoscope

Inspection of the tympanic membrane should include evaluation of its position, color, degree of translucency, and mobility [24].

Pneumatic Otoscopy

The appearance of a middle-ear effusion, the presence ofhigh negative middle-ear pressure, or both, determined by a pneumatic otoscop. A reasonable assessment of middle- ear pressure is possible by proper use of the pneumatic otoscope.

Nasopharyngoscopy and Endoscopy of the Eustachian Tube

Endoscopic examination of the nasopharyngeal end of the Eustachian tube system isimportant part of the clinical assessment of a patient with middle-ear disease.

Imaging of the Eustachian Tube

Imaging technology been used to better define the anatomy and pathology of the tubal system. Magnetic resonance imaging (MRI) has been used to visualize the Eustachian tube and to assess the Eustachian tube anatomy and pathology of patients with nasopharyngeal carcinoma. CT scan have been used to assess clearance function of the ET. Others have used CT scans to assess the tube in normal subjects, in those who had otitis media, and in patients with a patulous ET [34].

Tests of pressure regulation function of the eustachian tube are include Classic tests, Valsalva's test, Politzer's test, eustachian tube catheterization (ETC), and Toynbee test [34].

Tests of pressure regulation function when the tympanic membrane is intact are include manometry, tympanometry or sonotubometry [24, 25], in addition to Holmquist's method, and Bluestone's nine-step test.

Free field speech testing is performed with the subject facing forward and the examiner stationed opposite the ear to be tested. The patient should not be able to see theexaminer's lips move. It is necessary to mask the non-test ear. A number ofletter-number combinations are repeated. If the patient repeats more than 50 % of the number-letter combinations accurately, the examiner knows that the test procedure has been understood. The test is then repeated with a whispered voice [26].

Tuning forks are used to distinguish between a conductive and a sensorineural hearing loss. There are two commonly used tuning forks: 256, 512 Hz. Tuning forks are activated by striking them lightly against the elbow. The sound generated should not be audible until the fork is brought close to the ear.

The Rinne test is usedto compare air conduction with bone conduction. Under normal circumstances, air conduction is better than bone conduction and the tuning fork will be louder opposite the ear canal (air conduction) rather than when placed on the mastoid bone behind the ear (bone conduction, (positive test). If the sound is heard by bone conduction better than air conduction and the test is negative.

The Weber tuning fork test is based on a tuning fork placed centrally on the skull being heard louder in an ear with a conductive impairment or in an ear with better sensorineural thresholds. The test is performed by placing an activated tuning fork over the forehead, on the bridge of the nose, over the incisor teeth, or placed in the midline over the vertex of the skull. The patient is asked to identify in which ear the sound is heard or alternatively in which ear the sound is louder. If it is heard in the better hearing ear then the poorer ear has a sensorineural impairment. If it is heard in the poorer ear then it has a conductive impairment [23, 24].

The Bing test is performed by placing the activated tuning fork on the mastoid process and then occluding the external auditory canal.If the sound increases then there is unlikely to be a conductive deafness present. However, if it remains the same, then a conductive deafness is likely.

Pure-tone audiometry is the most commonly used test for evaluatingauditory sensitivity. Auditory pure-tone signals are delivered through air conduction and bone conduction. Most often, *threshold* is defined as the lowest signal intensity at which multipl presentations are detected 50% of the time.

When used clinically, audiometric threshold data are displayed on a graphic plot called an *audiogram*. Various symbols are used to represent data obtained for the right and left ears by use of air-conducted and bone-conducted signals. Data are presented in hearing level (HL), which is calibrated to referent sound that represent the hearing sensitivity of normal young adults when tested under reasonably quiet test conditions. An audiogram

represents a patient's ability to hear sounds compared with the hearing sensitivity of a group of normal young adults [26, 27].

Pure-Tone Air-Conduction Testing

Pure-tone air-conduction thresholds measure the function of the total hearing system, including the external, middle, and inner ear. In typical audiometric testing, pure tones that range in octave spacings from 250 to 8000 Hz are presented to the listener by headphones. Threshold is determined by the use of the *Hughson-Westlake* "ascending method, in which sound are initially presented well above threshold, and are then presented in decreasing steps of 10 to 15 dB until the sound is inaudible. The tone is increased in "up 5-dB, down 10-dB steps" until the single HL at which a response is obtained three times is reached.Because air-conduction thresholds measure the acuity of the entire hearing system, when evaluated alone they provide little information regarding the etiology of hearing loss and specific auditory pathology. When examined in conjunction with thresholds obtained by bone-conduction testing, however, they help determine the type and the severity of the hearing loss. When plotted on an audiogram, pure-tone thresholds also provide information regarding the severity of the hearing loss.

Pure-Tone Bone-Conduction Testing

Pure-tone bone-conduction thresholds provide auditory threshold information when the cochlea is stimulated more or less directly, with stimuli bypassing external and middle ear structures. Differences between thresholds obtained through air and bone conduction are used to determine the type of hearing loss (normal hearing versus conductive loss versus sensorineural hearing loss [SNHL]) and the magnitude of conductive hearing loss if it exists. The location of the bone-conduction thresholds on the audiogram helps determine the severity of the hearing loss.

Speech Testing

Another essential component of the audiologic test battery is the evaluation of the listener's ability to detect and recognize speech. Three speech tests are commonly included in the audiologic test battery:

determination of the speech detection threshold (SDT),determination of the speech reception threshold (SRT),and speech discrimination or recognition.

The SDT indicates the intensity level at which a listener can barely discern the presence of a speech signal 50% of the time. With such a task, the listener is not required to recognize the stimulus, but is merely asked to acknowledge itspresence. Conversely, the SRT represents the intensity level at whichlistener can repeat 50% of the speech material. In contrast to the SDT, the SRT requires the listener to repeat the word that was presented. The SRT is usually 8 to 9 dB higher than the SDT, whereas the SDT usually coincides with the pure-tone average (PTA), an average of the pure-tone thresholds obtained at 500 Hz, 1000 Hz, and 2000 Hz. The SDT and SRT can be obtained using either air conduction or bone conduction. Patient with a conductive hearing loss frequently has excellent speech discrimination scores when test stimuli are presented at a sufficiently loud level. Patients with a cochlear sensory hearing loss often have reduced scores on speech discrimination tests, even when the stimuli presented are well within their audible range. Patients with lesions of the eighth cranial nerve or beyond tend to has lower speech discrimination scores than patients with a cochlear lesion site, and may have reduced speech discrimination in the presence of normal auditory pure-tone thresholds. The extreme of this phenomenon may be found in patients with cortical lesions who are unable to understand speech or any type of complex auditory signal [27].

Otitis Media With Effusion

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, An effusion may be either serous (thin, watery), mucoid (viscid, thick), or purulent (pus). The process may be acute (0 to 3 weeks in duration), subacute (3 to 12 weeks in duration), or chronic (greater than 12 weeks in duration).

Etiology of OME in children

1-*Eustachian tube dysfunction*

If the epithelium of the ET is inflamed, becomes oedematous and loses its cilia, then it will dysfunction as an aerator of the middle ear.

Causes of eustachin tube dysfunction:

viral upper respiratory tract infection

allergic reaction

pollutants such as cigarette smoke.

chronic nasopharyngeal infection in the adenoidal tissue or gastro-oesophageal reflux.

disorder of the palatine muscles

2- Craniofacial abnormalities

Children with a cleft palate, even if repaired, have deficient palatine muscles and resultant poor ET function. As a consequence, OME is virtually universal in infants with a cleft palate .

Children with Down or Turner syndrome are more likely to have OME.

3- *Allergy*:

The best evidence does not support allrgy as a risk factor for the occurrence or persistence of OME.

4- *Gastro-oesophageal reflux*:

the best evidence does not support allergy as a risk factor for the occurrence or persistence of OME [28].

In childhood OME, the main determinants of the prevalence are the age of the child and the season of the year. The prevalence is bimodal with the first and largest peak of 20 %at two years of age. Thereafter the prevalence decline, but there is a second peak of16 % at around five years of age. There is twice as many children being diagnosed with OME in the winter as opposed to the summer months.

Risk factors for occurrence of OME

1-Recurrent episodes of acute otitis media is likely to be the largest single factor for developing OME.

2- Contact with other children at home and at playgroups,

3- Hereditability: In children who had OME during the first two years of life, there was greater concordance in monozygotic sets in the number and duration of OME than in dizygotic sets.

4-Race: The prevalence in black children is no different from white children.

Chinese children may have a lower prevalence .

5- Gender: no different in boys and girls .

6-Smoking: the effect of parental smoking must be negligible.

Aetiology of otitis media with effusion in adults

In adults, the first important aspect of the management of OME is to identify any underlying pathology. Several factors are often found in association with OME, including: sinus infections, allergy, Eustachian tube dysfunction and nasopharyngeal (NP) pathologies (NPlymphoid hypertrophy or enlarged adenoidsor NP tumors) [29].

Functional Eustachian tube obstruction Transnasal endoscopy of the pharyngeal orifice of the ET was performed for ears with OME in adults. The findings were oedema of the orifice, blockage of the orifice by mucopurulent nasal discharge, atrophy of the orifice and normal appearance.

Barotrauma Eustachian tube can become obstructed during barotrauma and hyperbaric oxygen therapy (HBO). Poor mastoid pneumatization is also cited as a risk factor for development of OME.

OME is also seen as a complication following surgical procedures in the head and neck region. (e.g maxillectomy). Prolonged intubation is also reported to be a cause of postoperative OME. Patients with problems related to the immune system, such as multiple myeloma, cystic fibrosis, polyarteritis nodosa and immune deficiency syndrome may also present with OME.

In most cases, a careful history and physical examination will lead to the accurate diagnosis of OME. In OME, hearing loss may be the only symptom. The most definitivepartof the diagnosisis anappropriatephysical examination to confirm the presence or absence of middle ear pathology. A complete examination of the head and neck should be done first to identify the possibility of any predisposing condition such as craniofacial anomaly, nasal obstruction, palatal defect, or adenoid hypertrophy. *Otoscopy* represents the most critical part of the examination to establish diagnosis of OM . Use of the *pneumatic otoscope* is essential. Thepresence of middle ear effusion is most easily confirmed when there is a definite air-fluid level or when bubbles are clearly visible within the middle ear space.

However, findings commonly associated with OME include a severely retracted tympanic membrane with apparent foreshortening of the handle of the malleus and a reduction in tympanic membrane mobility. Occasionally, the tympanic membrane may be dull or thickened and have an amber hue. In severe cases, middle ear fluid may become

purplish or blue, indicating hemorrhage within the tympanic cavity. The color of the tympanic membrane is important but is not conclusive in making a diagnosis.

The use of *tympanometry* has been popularized to confirm the findings of pneumatic otoscopy. It provides an objective assessment of the mobility of the tympanic membrane as well as the ossicular chain. By measuring tympanic membrane impedance, one can accurately predict conditions of the middle ear space.

The hearing loss associated with OME should be documented whenever possible, especially in patients in whom chronic effusion is present. Although the presence of a conductive hearing loss does not confirm the diagnosis of COME, its presence does contribute to the confirmation of middle ear fluid. It is also important in documenting response to therapy [30].

After careful assessment and proper diagnosis of the condition, the family must be counseled thatin general, OME is a binign condition with a high spontaneous recovery rate and no long-term sequel. In most children, the main concern will be the hearing. It should be explained to the parents that the impairment associated with OME is very variable in degree and mild or moderate at most [31-33].

The disability can be minimized by hearing tactic, including:

• getting the child's attention before starting to talk;

• reducing the background noise as much as possible by turning off the television, etc.;

• facing the child so that they can see you talk;

• speaking in a normal voice both in volume, speed and emphasis, as close as possible to the child [34]. For children not at risk for speech and language or learning disabilities, “watchful waiting” may be appropriate. Hearing testing should be done ifmiddle ear effusionpersists for 3 months or longer or at any time that language delay, learning difficulties or significant hearing loss is suspected. If the average hearing level is below 20 dB, watchful waiting is suggested, but if it is greater than 40 dB in the better ear, surgery is recommended. For children with hearing level in the better ear between 21 and 39 dB, management is based on the duration of effusion and severity of symptoms. For children not at risk, examination at 3- to 6-month intervals until the fluid has resolved, hearing loss, language, or learning delays are identified or there are suspected structural abnormalities of the ear drum, is recommended [35].

- Decongestant/Antihistamine
- Antibiotics
- Mucolytics
- Systemic steroid
- Topical nasal steroids
- Autoinflation
- Myringotomy
- Myringotomy with Tympanostomy TubeInsertion
- Adenoidectomy

Methods

This prospective study included 31 patients with the diagnosis of OME, who were admitted to undergo myringotomy at the department of Otolaryngology / Hospital of Specialized Surgeries– Medical City (Baghdad), during the period between December 2011, to November 2012.

Patient selection

patients were diagnosed as having OME based on clinical and audiological tests, were under " watchful waiting" for three months, & received medical therapy, but without resolution of problem, and confirmed clinically immediately before the operation.

Exclusion criteria :

- Patient with craniofacial and other congenital anomalies
- Patients who had previous ear surgery
- Previous history of ear discharge.
- Recurrent OME

In our study we compare the operative findings ofmyringotomy with pre-operative findings of otoscopy, pneumatic otoscopy, audiometry, tympanometry, then we assess their accuracy.

Results

There were 31 patients,with a mean age (8.3 ± 3.4) yearsand the range was (3-15) years.Among them there were 14 males (45.2%) and 17 females (54.8%).

Age and sex distribution of the study

Variable		**Value**
Age (years)	Mean SD	8.3 3.4
	Range	3-15
Sex	Male	14 (45.2)
	Female	17 (54.8)
	Total	31

OtoscopicexaminationThe tympanic membrane colour

Tympanic membrane colour	**Right ear**	**Left ear**	**Total**
Amber	20	18	38
	64.5%	58.1%	61.3%
Grey	11	13	24
	35.5%	41.9%	38.7%
Total	31	31	62
	100%	100%	100%

Translucency

Translucency	**Right ear**	**Left ear**	**Total**
Translucent	13	14	27
	41.9%	45.2%	43.5%
opaque	18	17	35
	58.1%	54.8%	56.5%
Total	31	31	62
	100%	100%	100%

Retraction

Retraction	**Right ear**	**Left ear**	**Total**
Yes	31	30	61
	100.0%	96.8%	98.4%
No	0	1	1
	.0%	3.2%	1.6%
Total	31	31	62
	100%	100%	100%

Fluid level

Fluid level	**Right ear**	**Left ear**	**Total**
Present	7	7	14
	22.6%	22.6%	22.6%
Absent	24	24	48
	77.4%	77.4%	77.4%
Total	31	31	62
	100%	100%	100%

Tympanic membrane mobility on pneumatic otoscopy

Pneumatic otoscopy (Mobility)	**Right ear**	**Left ear**	**Total**
Impaired	26	26	52
	83.9%	83.9%	83.9%
Normal	5	5	10
	16.1%	16.1%	16.1%
Total	31	31	62
	100%	100%	100%

Tuning fork tests

Audiological finding		**Right ear**	**Left ear**	**Total**
Rinne test	Positive	5	6	11
		16.1%	19.4%	17.7%
	Negative	23	22	45
		74.2%	71.0%	72.6%
	Not performed	3	3	6
		9.7%	9.7%	9.7%
Weber	Central			6
				19.4%
	Right side			1
				3.2%
	Not performed			24
				77.4%

Audiological finding		**Right ear**	**Left ear**	**Total**
Tympanometry	Flat	21	23	44
		67.7%	74.2%	71.0%
	Normal	10	8	18
		32.3%	25.8%	29.0%
Air – Bone gap (dB)	Mean ± SD	31.6 ± 8	33.2 ± 8.1	32.5 ± 8

Myringotomy Finding

Myringotomy Finding		**Right ear**	**Left ear**	**Total**
Positive	Clear fluid	15	10	25
		48.4%	32.2%	40.4%
	Glue	12	14	26
		38.7%	45.2%	41.9%
Negative	Dry	4	7	11
		12.9%	22.6%	17.7%
Total		31	31	62
		100.0%	100.0%	100.0%

Comparing myringotomy with otoscopy

Clinical finding		**Myringotomy**		**Total**
		Positive	**Negative**	
Otoscopy				
Tympanic membrane colour	Amber	34	4	38
		89.5%	10.5%	100.0%
	Grey	17	7	24
		70.8%	29.2%	100.0%
Translucency	No	33	2	35
		94.3%	5.7%	56%
	Translucent	18	9	27
		66.7%	33.3%	100.0%

Clinical finding		**Myringotomy**		**Total**
		Positive	**Negative**	
Otoscopy				
Retraction	Yes	51	10	61
		83.6%	16.4%	100.0%
	No	0	1	1
		0.0%	100%	100%
Fluid level	Yes	13	1	14
		92.9%	7.1%	100%
	No	38	10	48
		79.2%	20.8%	100%

Comparing pneumatic otoscopy with myringotomy

Clinical finding		**Myringotomy**		**Total**
		Positive	Negative	
Pneumatic Otoscopy :Mobility	Impaired	46	6	52
		88.5%	11.5%	100%
	Normal	5	5	10
		50%	50%	100%

Comparing Rinne test with myringotomy

Audiological test		**Myringotomy**		**Total**
		Positive	**Negative**	
Rinne test	Abnormal	39	6	45
		86.7%	13.3%	72.6%
	Normal	10	1	11
		90.91%	9.09%	17.7%
	Total	49	7	56
		87.50%	12.50%	90.3%

Comparing tympanometry with myringotomy

test		**Myringotomy**		**Total**
		Positive	**Negative**	
Tympanometry	Flat	35	9	44
		79.6%	20.4%	71.0%
	Normal	16	2	18
		88.9%	11.1%	29.0%
	Total	51	11	62
		82.3%	17.7%	100%

Comparison of mean Air bone gap distributed byMyringotomy finding

Myringotomy finding	**N**	**Air bone gap(dB)**	
		Mean	SD
Glue	26	35.3	8.205
Clear fluid	25	30.6	6.443
Dry	7	28.7	9.725

The validity of each clinical finding (sensitivity, specificity and accuracy) in diagnosis of OME compared to myringotomy finding

Clinical finding		**Sensitivity**	**Specificity**	**Accuracy**
Otoscopy	TM Colour	66.7%	63.6%	66.1%
	Translucency	64.7%	81.8%	67.7%
	Fluid level	25.5%	90.9%	37.1%
	Retraction	100.0%	9.1%	83.9%
Pneumatic otoscopy (TM mobility)	90.2%	45.5%	82.3%	

Validity ofotoscopyversusmyringotomy

	Myringotomy	**Total**		
	Positive	**Negative**		
Otoscopy	Positive	46	11	57
		74.2%	17.7%	91.9%
	Negative	5	0	5
		8.1%	.0%	8.1%
Total	51	11	62	
	82.3%	17.7%	100%	
Sensitivity	90.2%			
Specificity	0.0%			
Accuracy	74.2%			
Predictive value of positive finding	80.7%			
Predictive value of negativefinding	0.0%			

Validity of tuning fork tests

Audiological test		**Sensitivity**	**Specificity**	**Accuracy**
Tuning fork tests	Rinne test	79.6%	14.3%	71.4%
	Weber	14.3%	****	14.3%

Validity of tympanometry

Audiological test	**Sensitivity**	**Specificity**	**Accuracy**
Tympanometry	68.6%	18.2%	59.7%

Discussion

This study involved 31 patients (62 ears) prepared for myringetomy suspected to have otitis media with effusion (OME).

Patients were children; from age 3 – 15 years, 14 were males (45.2%) and 17 were females (54.8%),the mean age ofpatients was (8.3)years.

Otoscopic and pneumatic otoscopic examinations of tympanic membrane are recommended for assessment of the middle ear because it combines visualization of the tympanic membrane with a test of membrane mobility [36].

In many children, OME is preceded by an episode of acute otitis media with otalgia and fever. In the majority of children, acute otitis media is considered to have been triggered by a viral upper respiratory tract infection that damages the epithelium of the ET, resulting in retention of middle ear fluid. These secretions then become secondarly infected with bacteria - acute otitis media. Once the infection has resolved, it can take time for the epithelium to recover. Hence, OME will be present temporarily in many children after an episode of acute otitis media. However, many children with OME have no resent history of acute otitis media, albeit they may have had an upper respiratory tract viral infection. This damages the Eustachian tube epithelium with resultant retention of middle ear fluid, which in these children does not become secondarily infected [38].

Once OME is established, the normal, flat cuboidal middle ear and mastoid mucosa is patchily replaced by thickened pseudostratified mucus-secreting Epithelium. Goblet cells are frequently present and sometimes mucus-secreting glands are formed. The ciliary lining is less efficient at moving the secretions into the nasopharynx than normal .The

submucosa is oedematous and inflamed with dilated blood vessels and an increased number of macrophages, plasma cells and lymphocytes.

Otoscopy (non-pneumatic): Tympanic membrane found to be amber in 38 ears (34 of them were positive on myringetomy) with sensitivity (66.7%)and specificity (63.6%).

Loss of translucency is a feature suggestive of MEE, cloudiness of the tympanum were foundin 35 ears and shows the highest sensitivity and specificity than other otoscopic finding; sensitivity (64.7%)and specificity (81.8%).

Retracted tympanum in 61 ears of them (83.6%) discovered to contain middle ear effusion on myringetomy.

Depending on each of these findings the pooled sensitivity of otoscopy versus myringetomy was (90.2%) but it was not specific (specificity; 0%) so that,good-quality evidence on the diagnostic performance of otoscopy is lacking, these finding goes in line with that ofa study conducted in the UK, in which otoscopy results were compared with findings of myringotomy in 120 children with OME, the available evidence in this study that otoscopy was highly sensitive but poorly specific (98% and 18%) respectively [2].

Pneumatic otoscopy versus myringotomy (threshold: impaired mobility of tympanic membrane);sensitivity was (90.2%), specificity was (45.5%) and accuracy was (82.3%).These findings came consistentwith a study conductedby Toner J. G. and Mains B. on121 patients (222 ears),pneumatic otoscopy and tympanometry were performed prior to myringetomy,authorsconcluded that sensitivityof pneumatic otoscopy (88%) and when pneumatic otoscopy and tympanometry were used in conjunction, the predictive accuracy did not increase significantly [8], but, these findings aredifferent from other study conductedby Takata G.S. et al. they claimed that pneumatic otoscopy had the best apparent performance [9].

Therefore non pneumatic otoscopy is not advised for primary diagnosis of OME, while pneumatic otoscopyremain a valuableprimary method of OME diagnosis because it is readily available in practice settings, cost effective, and accurate in experienced hands. However, examiner qualifications were reported inconsistently and the accuracy of pneumatic otoscopy in routine clinical practice may be less than that shown in published results because clinicians have varying training and experience.

Abnormal Rinne test in 39children, of them (86.7%) hadpositive finding on myringetomy giving a sensitivity of (79.6%) and a specificity of (14.3%).

Weber test was lateralized to the right side in one patient who had positive finding on myringetomy (Glue in the right ear), and it was central in 6 patients (12 ears) all with positive finding on myringetomy, giving a sensitivity of (14.3%)while specificity couldn't be calculated, the pooled sensitivity and specificityfor both tests together were much higher than each test alone (96.1% and 36.4%) respectively with an accuracy of(85.5%). The finding of this study is varied from other published studies; YungMWin a study included 100 children aged 2-12 years, foundRinne test had a sensitivity of 89% and a specificity of 73% when the results of both unilateral and bilateral effusion were taken together. In cases of unilateral OME only, the Weber test showed a sensitivity of 79% and a specificity of 91% [10].

The variationin these finding might be attributedto the conflicting evidence regarding the diagnostic value of tuning fork tests in children.

Moreover, the evidence is characterized by a lack of clarity regarding the examiner's capability, the methodology used and the time interval between the tests and the myringotomy [37-39].

Tympanometry value as a diagnostic test for OME was questionable, it was normal in 18 patients and it was flat in 44 patients of them 35 had a positive finding on myringetomy (true positive), giving a moderatesensitivity (68.6%) and low specificity (18.2%) while accuracy was (59.7%), in this finding, the current study disagree with the finding of Dong et al (Korean, 2004) he found sensitivity and specificity (87.5%) and (0%) respectively [1].

The mean Air-Bone gap was widely exceeded normal limitsamong studied group in both ears and it was (32.6) dB and this means there likely is a conductive or mixed hearing loss present. This is similar to finding of Arick D.S et al study (USA) he found the mean air-bone gap (33.8) Db [40]. Therefore, it should be always kept in mind that there are many raise positive and false negative cases and that interpretation of tympanogram must require consideration and matching with findings of tympanic membrane examination [40].

Conclusions

Otoscopy has a sensitivity 90.2%, but not specific. Rinne test has sensitivity 79.6%, specificity 14.3%. Tympanometry give sensitivity 68.6%, specificity 18.2%.Pneumatic otoscopy is an accurate diagnostic tool for detection of OME if performed by well-trained otolaryngologist.It does not require complicated electronic machines or software, it is atraumatic, non-invasive and repeatable . it does not require cooperation from the patient.It has sensitivity 90.2%, specificity 45.5%, and accuracy 82.3%.

Conflict of interesting

None

Funding

None

References

1. Lee D, Yeo S. Clinical Diagnostic Accuracy of Otitis Media with Effusion in Children, and Significance of Myringotomy: Diagnostic or Therapeutic? J Korean Med Sci 2004; 19:739.
2. Ungkanont K, Charuluxanannan S., Komoltri C. Association of otoscopic findings and hearing level in pediatric patients with otitis media with effusion.International Journal of Pediatric Otorhinolaryngology 2010; 74:1063.
3. National Collaborating Centre for Women's and Children's Health, UK,Surgical management of otitis media with effusion in children, 2008; 1
4. National Collaborating Centre for Women's and Children's Health, UK,Surgical management of otitis media with effusion in children, 2008; 14.
5. National Collaborating Centre for Women's and Children's Health, UK,Surgical management of otitis media with effusion in children, 2008; 18.
6. Browning G, Otitis media with effusion in Scott-Brown'sOtorhinolaryngology, Head and Neck Surgery, 2008; 7th edition (1):877-82
7. Kenna M., Latz A, Otitis Media with Effusion, in Bailey, Byron Head & Neck Surgery - Otolaryngology,2006, 4th Edition; 1266.

8. Tong M and Hasselt C, Otitis Media with Effusion In Adults in: Scott-Brown's Otorhinolaryngology, Head and Neck Surgery, 2008; 7th edition (3):3388-90.
9. Healy G and Rosbe K, Otitis Media and Middle Ear Effusions in Ballenger's Olothinolaryngology Head and Neck Surgery, 16th Edition, Jr 1, Ballenger1.2003: 252.
10. Browning G, Otitis media with effusion in Scott-Brown'sOtorhinolaryngology, Head and Neck Surgery, 2008; 7th edition (1): 895.
11. Casselbrant M and Mandel E, Acute Otitis Media and Otitis Media with Effusion in: Cummings Otolaryngology Head & Neck Surgery Sth edition,Paul W. F, Mosby Elsevier, Philadelphia; 2010 (3): 2771.
12. Casselbrant M and Mandel E, Acute Otitis Media and Otitis Media with Effusion in: Cummings Otolaryngology Head & Neck SurgerySth edition, PaulW. F, Mosby Elsevier, Philadelphia; 2010 (3):2772 - 73.
13. Francis W. S., Anatomy of the Temporal Bone, External Ear, and Middle Ear in: Cummings Otolaryngology Head & Neck Surgery, Sth edition, Paul W.F, Mosby Elsevier, Philadelphia; 2010 (2): p1823.
14. Wright T. and Valentine P. The anatomy and embryology of the external and middle ear in: Scott-Brown's Otorhinolaryngology, Head and Neck Surgery, 2008; 7th edition, (3): 3108.
15. Gelfand, A. Anatomy in: Hearing: An Introduction to Psychological and physiological Acoustics, Sth Edition: p. 25.
16. Wright T. and Valentine P. The anatomy and embryology of the external and middle ear in: Scott-Brown's Otorhinolaryngology, Head and Neck Surgery, 2008; 3rd edition, (3): 3109.
17. Francis W. S., Anatomy of the Temporal Bone, External Ear, and Middle Ear in: Cummings Otolaryngology Head & Neck Surgery, Sth edition, PaulW. F, Mosby Elsevier, Philadelphia; 2010 (2): p. 1825.
18. Wright T. and Valentine P. The anatomy and embryology of the external and middle ear in: Scott-Brown's Otorhinolaryngology, Head and Neck Surgery, 2008; 3rd edition, (3): 3110.
19. Francis W. S., Anatomy of the Temporal Bone, External Ear, and Middle Ear in:

Cummings Otolaryngology Head & Neck Surgery, Sth edition, PaulW. F, Mosby Elsevier, Philadelphia; 2010 (2): p.1826.

20. Wright T. and Valentine P. The anatomy and embryology of the external and middle ear in: Scott-Brown's Otorhinolaryngology, Head and Neck Surgery, 2008; 3rd edition, (3): 3112, 13, 14.
21. Gelfand, A. Anatomy in: Hearing: An Introduction to Psychological and Physiological Acoustics, 2010, 5th Edition: 27, 8.
22. Wright T. and Valentine P. The anatomy and embryology of the external and middle ear in: Scott-Brown's Otorhinolaryngology, Head and Neck Surgery, 2008; 7th edition (3):3115, 6.
23. Wright T. and Valentine P. The anatomy and embryology of the external and middle ear in: Scott-Brown's Otorhinolaryngology, Head and Neck Surgery, 2008; 7th edition (3): 3118.
24. Bluestone, D. Anatomy and Physiology of the Eustachian Tube System in : Bailey, Byron Head & Neck Surgery - Otolaryngology, 4th Edition 2006 (1):1256.
25. Francis W. S., Anatomy of The Temporal Bone, External Ear, and Middle Ear in: Cummings Otolaryngology Head & Neck Surgery, 5th edition, PaulW. F, Mosby Elsevier, Philadelphia; 2010 (2): 1829.
26. Chien W. Physiology of the Auditory System in: Cumming's otolaryngology Head & Neck Surgery, 5th edition, Paul W. F, Mosby Elsevier, Philadelphia; 2010(2): 1849.
27. Pickles O J., Physiology of hearing in: Scot-Brown's Otorhinolaryngology, Head and Neck Surgery, 2008; 7th edition (3):3178.
28. Pickles OJ., Physiology of hearing in: Scott-Brown's Otorhinolaryngology, Head and Neck Surgery, 2008; 7th edition (3): 3179.
29. Chien W., Physiology of the Auditory System in: Cummings otolaryngology Head & Neck Surgery, 5th edition, Paul W. F, Mosby Elsevier, Philadelphia; 2010 (2): 1839.
30. Bluestone, D. Anatomy and Physiology of the Eustachian Tube System in: Bailey, Byron Head & Neck Surgery - Otolaryngology, 4th Edition 2006 (1):1258.
31. Tewfik T., Eustachian Tube Function, Ventilation or pressure regulation, available at:http://emedicine.medscape.com/article/874348-overview#aw2aab6b6.
32. O'Reilly C., Anatomy and Physiology of the Eustachian Tube in:Cummings

otolaryngology Head & Neck Surgery, 5th edition, Paul W. F,Mosby Elsevier, Philadelphia; 2010 (2): 1870, 71, 72, 73, 74.

33. Bluestone C, Diagnosis and Tests of Function in: Eustachian Tube:Structure, Function, Role in Otitis Media; 2005:113-31.
34. Hall J., Lewis S, Diagnostic Audiology, Hearing Aids, and ,Habilitation Options in: Ballenger's Otorhinolaryngology Head and Neck Surgery, 16thEdition, Jr J, Ballenger J,2003:138-39.
35. WORMALD P, Clinical examination of the ears and hearing in: Scott-Brown's Otorhinolaryngology, Head and Neck Surgery, 2008; 7th edition(3):3317, 18.
36. Kileny P. and Zwolan I, Diagnostic Audiology in: Cummings Otolaryngology Head & Neck Surgery 5th edition, Paul W. F, Mosby Elsevier, Philadelphia; 2010 (2): 1888.
37. National Collaborating Centre for Women's and Children's Health, UK,Surgical management of otitis media with effusion in children, 2008; 22.
38. Takata G.S, Chan LS, Morphew T, Mangione-Smith R, Morton SG, Shekelle P, Evidence assessment of the accuracy of methods of diagnosing middle ear effusion in children with otitis media with effusion. Pediatrics2003; 112(6), 1379-1387.
39. Yung MW. Tuning-fork tests in diagnosis of serous otitis media. British Medical journal 199; 283: 1576.
40. Arick S.D., Silman S. Treatment of otitis media with effusion based on politzerization with an automated device. Ear Nose Throat J 2000; 79 (2):290-294.