A Comparative Study of Eustachian Tube Functions in Normal and Diseased Ears with Tympanometry and Videonasopharyngoscopy

Bhushan Chauhan · Komal Chauhan

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Abstract Eustachian tube is a bony and fibrocartilagenous tube extending from the antero-inferior part of middle ear cleft to lateral wall of the nasopharynx. Its main functions are ventilation of middle ear to equalize the middle ear pressure with atmospheric pressure and mucociliary clearance. The functioning of eustachian tube has a direct impact on normal middle ear function. As a corollary, dysfunction of eustachian tube inevitably leads to retraction of the tympanic membrane initially and sterile effusion and subsequent conductive deafness later. Secretory otitis media today is the most common cause of conductive deafness in children with an intact ear drum. Evaluation of function of eustachian tube assumes paramount importance in this scenario. To evaluate eustachian tube functions in normal and diseased ears with tympanometry and videonasopharyngoscopy and to compare the tympanometric tests of eustachian tube function with videonasopharyngoscopy and to assess their reliability. The study was conducted at Army hospital (R&R) Delhi Cantt from October 2005 to April 2007. Hundred (100) ears were examined and were divided into two groups, the control group with normal tympanic membrane on otoscopy and case group with complaints of diminished hearing and

intact but retracted tympanic membrane. Their eustachian tube function was evaluated by tympanometric tests and videonasopharyngoscopy. Thereafter a comparison was made between the two. The study revealed that videonasopharyngoscopy was highly accurate and reliable test for eustachian tube function as compared to tympanometry. Slow motion video analysis of eustachian tube dynamics is a useful tool for further understanding the pathophysiology of tubal dysfunction.

Keywords Eustachian tube · Tympanometry · Videonasopharyngoscopy · Visual analogue score

Introduction

Eustachian tube is a bony and fibrocartilagenous tube extending from the antero-inferior part of middle ear cleft to lateral wall of the nasopharynx. Its main functions are ventilation of middle ear to equalise the middle ear pressure with atmospheric pressure and mucociliary clearance. The functioning of eustachian tube has a direct impact on normal middle ear function. This is more so in children and in certain professions like pilots and deep sea divers, where body is subjected to sudden and drastic pressure variations. As a corollary, dysfunction of eustachian tube inevitably leads to retraction of the tympanic membrane initially and sterile effusion and subsequent conductive deafness later. Secretory otitis media today is the most common cause of conductive deafness in children with an intact ear drum. Evaluation of function of eustachian tube assumes paramount importance in this scenario.

Though conventional tests like tympanometry measurements are available, visual evaluation of eustachian tube orifice is now being evaluated to correlate the

B. Chauhan (✉)
Department of E.N.T., Gian Sagar Medical College and
Hospital, Ramnagar, Banur, Patiala, Punjab, India
e-mail: bhushan.chauhan11@yahoo.com

K. Chauhan
Department of Food Science & Nutrition, Banasthali University,
Banasthali Vidyapith, Jaipur, Rajasthan, India
e-mail: shivam_kim@yahoo.com

eustachian tube function. This is made possible by the rigid nasal endoscopes that are available today. Endoscope can be introduced into the nasal cavity and advanced up to the nasopharyngeal orifice of the eustachian tube just posterior to the inferior turbinate and torus tubarius can be identified. Further dynamics of eustachian tube can be evaluated by nasopharyngoscopy with slow motion video capture.

This study aims at evaluating the efficacy of nasopharyngoscopy as a tool for evaluating the eustachian tube function, by comparing its findings to conventional tympanometry in two cohorts of subjects with normal and retracted tympanic membrane.

Materials and Methods

This was a cross-sectional study conducted on 100 ears for a period of 18 months from October 2005 to April 2007 at Research and Referral (R&R) Hospital Delhi Cantt, India. Patients having a history of recent ear discharge, abnormal external auditory canal, acute infections of ear, perforated tympanic membrane were excluded. Patients were randomized alternatively into control group ($n = 50$ ears) and case group ($n = 50$ ears). The former having normal tympanic membrane on otoscopy and the latter included the ones, who had complaints of diminished hearing with intact but retracted tympanic membrane. Appropriate approval was procured from the Institution Review Board and informed consent was obtained from all the patients. They were subjected to routine ENT examination through otoscopy, tympanometry, videonasopharyngoscopy.

The data obtained from otoscopy was categorized into four grades according to Sade's classification viz. Grade 1—normal position of tympanic membrane with destruction of cone of light; Grade 2—pars tensa in contact with incus; Grade 3—tympanic membrane is not adherent to promontory and can be seen to move on pneumatic otoscopy. Grade 4—tympanic membrane is adherent to promontory.

The Grason Stadier Madison (GSI 38 Auto Tym) middle ear analyser was used for tympanometry. The tympanogram was evaluated with regard to the type of tympanogram (according to Jerger's classification).

Transnasal endoscopic examination was done using Hopkins rigid nasal endoscope. The other equipments used for assessing slow movements were video camera attached to the endoscope; a coloured television and video cassette recorder (VCR) for recording the images. Slow motion video analysis requires an approximate cost of Rs 4–5 lakh.

Videonasopharyngoscopy was based on visual analogue score (VAS) which recorded the motion factors and pathological factors as shown below. The maximum and minimum score obtained was 8 and 0.

S. no.	Visual analogue score (VAS)	Present	Absent
Motion factors			
1	Palatal elevation causing passive then active rotation of the medial cartilaginous lamina	1	0
2	Lateral excursion of lateral wall	1	0
3	Dilation of the lumen beginning distally and inferiorly	1	0
4	Opening of tubal valve at the isthmus level	1	0
Pathological factors			
1	Mucosal oedema	0	1
2	Pus/mucus discharge at tubal opening	0	1
3	Pus/mucus discharge at isthmus	0	1
4	Blockage of tubal opening by peritubal tissues	0	1

Following these tests, a comparison was made between the tympanometric and videonasopharyngoscopy tests for eustachian tube function.

Statistical Analysis

Statistical analysis of results was done by Proportion test (Z). The values with $P \leq 0.05$ were considered significant.

Results

Grading of Retraction on Otoscopy in Retracted Tympanic Membrane

Ears with retracted tympanic membrane were categorized into different grades. Grade 1 retraction was present in 60% ears while Grade 2, 3, and 4 retraction was present in 16%, 20%, and 4% ears as shown in Table 1.

Type of Tympanogram in Normal and Retracted Tympanic Membrane

Ears with normal tympanic membrane obtained Type-A tympanogram (100%) where as ears with retracted

Table 1 Grading of retraction based on otoscopy in retracted tympanic membrane

Grading of retraction	No. of ears (%)
1	30 (60)
2	8 (16)
3	10 (20)
4	2 (4)

Table 2 Tympanometric curve obtained in normal and retracted tympanic membrane

Type of tympanometric curve	Normal tympanic membrane (%)	Retracted tympanic membrane (%)
Type-A	100	36 ^a
Type-B	0	36 ^a
Type-C	0	28 ^a

^a $P \leq 0.05$ significant

tympanic membrane obtained different types of tympanogram viz. Type-A and -B tympanogram was obtained by equal number of ears (36%) and Type-C tympanogram was obtained by 28% ears as evident from Table 2. Statistical analysis revealed a significant difference ($P \leq 0.05$) in various types of tympanometric curves in ears with normal and retracted tympanic membranes (Figs. 1, 2, 3).

Motion Factors by Videonasopharyngoscopy in Normal and Retracted Tympanic Membrane

Active rotation of the medial cartilaginous lamina was present in all the ears (100%); lateral excursion of lateral wall in 96%; dilation of the lumen beginning distally and

inferiorly in 100% ears and opening of tubal wall at the isthmus level was absent in 96% ears with normal tympanic membrane (Table 3).

However, ears with retracted tympanic membrane showed that active rotation of the medial cartilaginous lamina was present in 60%, lateral excursion of lateral wall in 68%; dilation of the lumen beginning distally and inferiorly in 40% ears and opening of tubal wall at the isthmus level was absent in 100% ears. A significant difference ($P \leq 0.05$) was observed in active rotation of the medial cartilaginous lamina; lateral excursion of lateral wall and dilation of the lumen beginning distally and inferiorly as evident from Table 1.

Pathological Factors by Videonasopharyngoscopy in Normal and Retracted Tympanic Membrane

It was observed that ears with normal tympanic membrane showed that mucosal edema was present in 20% ears, pus/mucus discharge at tubal opening was present in 4%, pus/mucus discharge at isthmus was present in 8% ears and blockage of tubal opening by peritubal tissues was absent in all the (100%) ears as shown in Table 4.

In contrast ears with retracted tympanic membrane revealed that mucosal edema was present in 94% ears, pus/

Fig. 1 Normal eustachian tube (resting position) **Fig. 2** Normal eustachian tube (maximally dilated)

Fig. 3 Eustachian tube with mucosal edema and blockage of tubal opening by peritubal tissues **Table 3** Motion factors by videonasopharyngoscopy in normal and retracted tympanic membrane

S no.	Motion factors	Present		Absent	
		Normal tympanic membrane (%)	Retracted tympanic membrane (%)	Normal tympanic membrane (%)	Retracted tympanic membrane (%)
1	Palatal elevation causing passive then active rotation of the medial cartilaginous lamina	100	60 ^a	0	40 ^a
2	Lateral excursion of lateral wall	96	68 ^a	4	32 ^a
3	Dilation of the lumen beginning distally and inferiorly	100	40 ^a	0	60 ^a
4	Opening of tubal valve at the isthmus level	4	0 ^{NS}	96	100 ^a

NS non significant ($P \geq 0.05$)

^a $P \leq 0.05$ significant

Table 4 Pathological factors by videonasopharyngoscopy in normal and retracted tympanic membrane

S no.	Pathological factors	Present		Absent	
		Normal tympanic membrane (%)	Retracted tympanic membrane (%)	Normal tympanic membrane (%)	Retracted tympanic membrane (%)
1	Mucosal edema	20	94 ^a	80	6 ^a
2	Pus/mucus discharge at tubal opening	4	84 ^a	96	16 ^a
3	Pus/mucus discharge at isthmus	8	86 ^a	92	14 ^a
4	Blockage of tubal opening by peritubal tissues	0	60 ^a	100	40 ^a

^a $P \leq 0.05$ significant

mucus discharge at tubal opening in 84% ears, pus/mucus discharge at isthmus in 86% ears and blockage of tubal opening by peritubal tissues was present in 60% ears. A significant difference ($P \leq 0.05$) was observed in pathological factors in normal and retracted tympanic membrane as evident from Table 4.

Videonasopharyngoscopy Results Obtained in Normal and Retracted Tympanic Membrane

68% ears with normal tympanic membrane obtained VAS seven, 4% obtained eight and the remaining ones scored less than seven. On the other hand ears with retracted

tympanic membrane showed that 26% obtained VAS 0 and none of the ears obtained VAS of seven or more than seven as shown in Table 5. Statistically VAS score of two and eight did not showed a marked difference ($P \geq 0.05$) in ears with normal and retracted tympanic membrane.

Videonasopharyngoscopy Results Obtained in Retracted Tympanic Membrane with Types of Tympanometry Curve

Type-A tympanogram was obtained by 18 ears. VAS obtained by these ears was five or less than five. On the contrary Type-B and Type-C tympanogram was obtained

Table 5 Visual analogue score (VAS) in normal and retracted tympanic membrane

Visual analogue score (VAS)	Normal tympanic membrane (%)	Retracted tympanic membrane (%)
0	0	26 ^a
1	0	14 ^a
2	0	8 ^{NS}
3	0	14 ^a
4	4	18 ^a
5	0	12 ^a
6	24	8 ^a
7	68	0 ^a
8	4	0 ^{NS}

NS non significant ($P \geq 0.05$)

^a $P \leq 0.05$ significant

Table 6 Visual analogue score (VAS) in retracted tympanic membrane with type-A, B and C tympanometry curve

Visual analogue score (VAS)	Type of tympanometry curve	
	Type-A (no. of ears)	Type-B and -C (no. of ears)
0	0	13 (40)
1	0	7 (22)
2	0	4 (13)
3	8 (44)	7 (22)
4	6 (34)	1 (3)
5	4 (22)	0
6	0	0
7	0	0
8	0	0
Total ears	18	32

by 32 ears and VAS obtained was four or less than four as evident from the Table 6.

Comparison Between Tympanometry and Videonasopharyngoscopy Results Obtained in Normal and Retracted Tympanic Membrane

All the ears with normal tympanic membrane obtained Type-A tympanogram. VAS of seven or more than seven was obtained by 72% ears; VAS six, was secured by 24% ears and VAS of four was obtained by 4% ears. On the other hand Type-A tympanogram was obtained by 36% ears with retracted tympanic membrane but on performing videonasopharyngoscopy all the ears showed VAS less than seven, thus 100% ears showed eustachian tube dysfunction on videonasopharyngoscopy as shown in Table 7.

Discussion

The function of the eustachian tube was first recognized by Duvernay, who in 1683 stated that the eustachian tube was neither an avenue for breathing nor of hearing, but one through which the air in the tympanum is renewed. The primary role of the eustachian tube is to maintain the equality of air pressure across the tympanic membrane, which is necessitated by the absorption of gases through the mucous membrane in the middle ear and by the variation in ambient atmospheric pressure. This is achieved by opening the tube to permit the passage of air along it. In this study tympanometry and videonasopharyngoscopy were used to evaluate the eustachian tube functions. Thereafter, a comparison was made between the two.

Tympanometry is used as a routine diagnostic test for middle ear lesions. Furthermore, it is possible to determine

Table 7 Comparison between tympanometry and videonasopharyngoscopy in normal and retracted tympanic membrane

Normal tympanic membrane				Retracted tympanic membrane			
Type of curve	No. of ears (%)	Visual analogue score (VAS)	No. of ears (%)	Type of curve	No. of ears (%)	Visual analogue score (VAS)	No. of ears (%)
Type-A	50 (100)	0	0	Type-A	18 (36)	0	13 (26)
Type-B	0 (0)	1	0	Type-B	18 (36)	1	7 (14)
Type-C	0 (0)	2	0	Type-C	14 (28)	2	4 (8)
		3	0			3	7 (14)
		4	2 (4)			4	9 (18)
		5	0			5	6 (12)
		6	12 (24)			6	4 (8)
		7	34 (68)			7	0
		8	2 (4)			8	0

middle ear pressure and to quantitatively assess eustachian tube function behind an intact tympanic membrane.

Videonasopharyngoscopy or slow motion video analysis of eustachian tube dynamics is a permanent record which can be used for diagnosis, patient counselling, resident teaching, and the monitoring of therapy in nasopharyngeal disorders. It is potentially a useful tool in the quest for understanding; documenting the anatomy and pathophysiology of nasopharynx or tubal dysfunction. Careful observation of tubal dynamics has become possible with high resolution optics, and avoidance of direct contact with the mucosa prevents interference with the dilating mechanism and limits problems with fogging of the lens. Various types of pathologies and their causes are being identified, viz. role of mucosal disease and muscular abnormalities in reducing the mechanical ability of the tube to dilate. As specific disease processes are identified, the possibility of future medical or surgical treatments may become easier and more of a reality [13].

Though tympanometry is conventionally used, videonasopharyngoscopy is adjuvant. An attempt must be made to define and quantify the various types of pathological changes that contribute to eustachian tube dysfunction by a better method. The various types of muscular dysfunction observed must be further investigated, and when they are completely understood, surgical corrective measures may be feasible using slow motion analysis technique.

The study was conducted on 100 ears with two groups, namely the control group with normal tympanic membrane on otoscopy and the case group with complaints of diminished hearing, but intact and retracted tympanic membrane. The age of subjects varied from 5 to 68 years.

Grading of Retraction on Otoscopy in Retracted Tympanic Membrane

The most important function of the eustachian tube is to maintain air pressure equally on both sides of the tympanic membrane. The continuous absorption of oxygen through the mucosal lining in the middle ear space together with the variation of ambient barometric pressure constitutes the basic need for intermittent air exchange through the eustachian tube. This is accomplished by opening the tube and admitting air either from or into the middle ear space [1, 2].

Besides air flow, drainage of mucous produced in the middle ear or in the eustachian tube itself is also a part of its function [3]. This function is accomplished, as the mucous membrane of eustachian tube consists of ciliated columnar epithelium and ciliary motion is towards the nasopharyngeal opening of the tube.

Due to the pressure differential between air in the middle ear space and that of the surrounding tissue, a small

amount of oxygen and nitrogen is continuously absorbed through the mucosal lining. This corresponds to a decrease in the middle ear pressure of approximately 50 mm of water per hour if the tube is closed. A slight negative pressure develops in the middle ear which is normally neutralised by tubal opening during deglutition. Deglutition occurs approximately once per minute in the awake subject and once every 5 min during sleep. Though deglutition may occur, the eustachian tube does not necessarily open during every swallow [4, 5].

Patency of the eustachian tube and adequate ventilation of the middle ear is important. Inadequate tubal function may lead to negative pressure in the middle ear (when air in middle ear is absorbed) [3, 6]. This leads to retraction of tympanic membrane and later to transudation of fluid into middle ear, thereby leading to secretory otitis media.

The medial displacement of the tympanic membrane or the retracted tympanic membrane is a common clinical finding. Also, retractions are looked upon as the precursor of middle ear cholesteatoma. In current otologic literature there seems to be some dispute whether the retractions of the tympanic membrane are caused by negative intratympanic air pressure or by shrinkage of middle ear adhesions pulling the tympanic membrane or part of it medially [7].

Retraction pockets of the pars tensa have been classified into four stages or grades by Sade [8]. In Grade 1 there is mild retraction of the tympanic membrane. In Grade 2, pars tensa is in contact with incus. In Grade 3, the tympanic membrane is not adherent to promontory and can be seen to move on pneumatic otoscopy, while in grade 4 the tympanic membrane is adherent to promontory.

The study revealed that Grade 1 retraction was present in 60% ears. Where as Grade 2, 3, and 4 retraction was present in 16, 20, and 4% ears, respectively. Out of the 30 ears (60%) that had Grade 1 retraction, 60% had Type-A, 27% had Type-B and 30% had Type-C tympanogram. In contrast, out of eight ears that had Grade 2 retraction, 25% had Type-B and 75% had Type-C tympanogram. Furthermore, out of ten ears that had Grade 3 retraction, 60% had Type-B and 40% had Type-C tympanogram. The remaining two ears (4%) that showed Grade 4 retraction had Type-B tympanogram. Thus, it was observed that Type-A tympanogram was present only in Grade 1 retraction. The results are in agreement with another study conducted by Zheng et al. [9] that analyzed the clinical manifestation of attic retraction pocket on ninety-two patients with 118 involved ears. Using Tos's classification, it was observed that Grade 1 retraction was present in 12.7% patients. Grade 2, 3 and 4 retraction was present in 40.7, 19.5 and 27.1% patients, respectively indicating that Type-B or C were more common in most of the cases.

Type of Tympanogram in Retracted Tympanic Membrane

Tympanometry is the measurement of the change of impedance of the middle ear at the plane of the tympanic membrane as a result of changes in air pressure in the external auditory meatus. In this way, the air pressure at which the ear function most effectively, i.e., transmits the highest amount of sound, can be determined. This particular pressure is the pressure of the air inside the middle ear cavity and is referred to as the middle ear pressure. In a study conducted by Brooks [10] the middle ear pressure is normally zero (atmospheric). A resting middle ear pressure outside the range of -100 to $+50$ mm of water pressure indicates abnormal tubal function.

Compliance of the tympanic membrane is measured as the relative change in the sound pressure level (SPL) in the entrapped ear canal cavity as the air pressure is increased and decreased. Brooks [10] has defined the normal limits of compliance as from 0.3 to 1.5 ml. Values below 0.28 ml or above 1.72 ml are considered as abnormal.

First the air pressure is raised to $+200$ mms of H_2O and the ear drum is clamped into a position of poor compliance. Air pressure is then reduced in the ear canal permitting the compliance of tympanic membrane to increase. As negative pressures are created, compliance again decreases. The result of the change from positive to negative air pressure, or vice versa is a tympanogram in graph form.

In the study conducted by Jerger [11] and Liden et al. [12] they used a coding (typing) system which types some common patterns of tympanogram. In this system, the shapes of the curve fall into three basic types—Type-A, -B and -C. In Type-A tympanogram, there is sharp maximum at or near 0 mms of H_2O seen in normal and otosclerotics individuals. In Type-B tympanogram, there is little or no maximum compliance seen in secretory otitis media and adhesive otitis media. In Type-C tympanogram, maximum is shifted to the left of zero by negative pressure in middle ear. Negative pressures equal to or more than -100 mm of H_2O are significant.

The present study showed that 36% ears obtained Type-A tympanogram and the remaining 64% ears obtained Type-B and -C tympanogram. Another study conducted by Holmquist et al. [7], observed similar results demonstrating that 33% patients obtained Type-A tympanogram as compared to 67% of the patients that obtained Type-B and -C tympanogram.

Motion and Pathological Factors by Videonasopharyngoscopy in Normal and Retracted Tympanic Membrane

Transnasal endoscopic examination of the nasopharyngeal opening of the eustachian tube during rest, swallowing and

Valsalva maneuver was done using Hopkins rigid nasal endoscope. Endoscope was introduced into the nasal cavity and advanced up to the nasopharyngeal orifice of the eustachian tube just posterior to the inferior turbinate and identified by torus tubarius. The tubal opening at the pharyngeal end of the tube is then assessed. Video recordings were made and replayed in slow motion for meticulous analysis of the dilation process and study of normal physiology and pathophysiology.

Pathological factors in normal tympanic membrane revealed that lateral wall motion was present in 96%; dilation of lumen in 100%; mucosal edema in 20% ears. However, the blockage of tubal opening by peritubal tissues was absent in 100% ears.

Likewise, a previous study conducted by Poe et al. [13] observed pathological factors by videonasopharyngoscopy in normal tympanic membrane pointing that lateral wall motion was present in 91%; dilation of lumen in 68%; mucosal edema in 18% patients and blockage of tubal opening by peritubal tissues was absent in 91% patients.

Studies (Prades et al. [14] and Poe et al. [15]) have shown that dilation of eustachian tube is thought to initially require dilation of the nasopharyngeal orifice by the action of the levator veli palatini (LVP) muscle, causing medial rotation of the medial cartilaginous lamina and medial wall of the tube. The action of the LVP may serve as a scaffold against which the tensor veli palatini (TVP) can more efficiently contract. The active dilator of the tubal lumen is thought to be the TVP, which runs longitudinally in the lateral wall of the tube. Opening of the cartilaginous portion of the tubal isthmus is theorized to occur, in part, from separate fascicles of the TVP, which insert on the membranous lateral wall and are known as the dilator tubae muscle. Poe et al. [13] observed that failure of tubal dilation was most commonly caused by mucosal edema and next by reduced dilatory motion of the lateral eustachian tubal wall. Mucosal edema could result in reduced eustachian tube dilation either from mechanical thickening and stiffening of the walls or from secretory proteins with increased fluid viscosity. Edema in the tube distal to the isthmus could be the result of primary mucosal disease, inflammatory conditions, infection, or allergy; and edema within and proximal to the isthmus could also result from excessive negative middle ear pressure, creating functional closure of the lumen.

Pathological factors in retracted tympanic membrane revealed that lateral wall motion was present in 68%; mucosal edema in 94% and blockage of tubal opening by peritubal tissues in 60% ears. However, dilation of lumen was absent in 60% ears.

However, Poe et al. [13] observed pathological factors by videonasopharyngoscopy in retracted tympanic membrane and concluded that, lateral wall motion was present

in 74%; mucosal edema in 83% and blockage of tubal opening by peritubal tissues in 26% patients and dilation of lumen was absent in 100% ears.

Takahashi et al. [16], conducted transnasal endoscopy of the pharyngeal orifice of the eustachian tube on 155 ears with otitis media with effusion (77 ears of children, 78 ears of adults). In children, blockage of the orifice by mucopurulent nasal discharge was the most frequent (72.7%), followed by compression of the orifice by the adenoid tissue (52.0%), hypertrophy of the peritubal tonsil (16.9%), and edema around the orifice, especially at its posterior lip (10.4%). In adults, the most frequent abnormal finding was edema of the orifice (26.9%), followed by blockage of the orifice by mucopurulent nasal discharge (23.1%), and atrophy of the orifice (10.3%). In 39.7% of cases findings were normal. Thus, main pathological findings associated with tubal dysfunction involved inflammation in the nasopharynx.

VAS in Retracted Tympanic Membrane with Type-A, Type-B and Type-C Tympanograms

Videonasopharyngoscopy was based on a VAS which was measured by rerunning the video in slow motion and recording the following parameters.

Score 1 was given if motion factors (e.g., palatal elevation causing passive then active rotation of the medial cartilaginous lamina, lateral excursion of lateral wall, dilation of the lumen beginning distally and inferiorly and opening of tubal valve at the isthmus level) were present. Score 0 was given if motion factors were absent.

Score 1 was given if pathological factors (e.g., mucosal edema, pus/mucus discharge at tubal opening, pus/mucus discharge at isthmus and blockage of tubal opening by peritubal tissues) were absent. Score 0 was given if pathological factors were present.

The data in the present study shows that 18 (36%) ears out of 50 obtained Type-A tympanogram with retracted tympanic membrane. Out of these 18 ears, VAS of 5, 4, and 3 was obtained by 22, 34, and 44% ears. Although, ears obtained Type-A tympanogram, however, VAS of five or less than five indicates eustachian tube dysfunction. Moreover, the ears showed various pathologies like mucosal edema, pus/mucus discharge at tubal opening which causes obstruction at nasopharyngeal opening of the eustachian tube. Thus, indicating that videonasopharyngoscopy is more accurate and reliable for assessment of eustachian tube function as compared to tympanometry.

On the other hand out of 50 ears with retracted tympanic membrane, 18 (36%) obtained Type-B tympanogram and 14 (28%) obtained Type-C tympanogram. Thus, 32 ears showed eustachian tube dysfunction in case of tympanometry. Furthermore, videonasopharyngoscopy, revealed

that VAS of four or less than four, indicating dysfunction of the eustachian tube. The primary cause of eustachian tube dysfunction in 30 (94%) ears out of 32 was found to have blockage of tubal opening by peritubal tissues. Thus, all the 32 ears showed the eustachian tube dysfunction both on tympanometry and videonasopharyngoscopy.

Conclusion

Tympanometry can be used as a routine diagnostic test but videonasopharyngoscopy is an adjuvant. Moreover, it is a more reliable and useful tool for further understanding the pathophysiology of tubal dysfunction as compared to tympanometry. The various types of pathologic conditions and possible causes can be identified, such as the role of mucosal disease and muscular abnormalities in reducing the mechanical ability of the tube to dilate. As specific disease processes are identified, the possibility of future medical or surgical treatments may become more of a reality. Thus, videonasopharyngoscopy provides a better platform for research and surgical procedures.

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