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## The Eustachian Tube and Sinonasal and Nasopharyngeal Masses: A Prospective Study on Functional Impacts

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### Abstract

**Background:** Nasal airway patency is essential for ear health, with nasal and paranasal sinus conditions potentially causing eustachian tube (ET) dysfunction. This dysfunction can reduce middle ear ventilation, leading to tympanic membrane retraction, otitis media with effusion, and chronic middle ear disease. **Aim:** This study aimed to assess how sinonasal and nasopharyngeal masses affect ET function using impedance audiometry. **Materials and Methods:** A prospective hospital-based study was conducted with 90 patients having sinonasal and nasopharyngeal masses. Impedance audiometry was performed before treatment and at 2-, 4-, and 6-weeks post-treatment. **Results:** The most affected age group was 15-24 years (32.22%), with a male-to-female ratio of 2:1. Before treatment, 41.67% of ears had tympanic membrane retraction and 30% had abnormal tympanograms. Post-treatment, retraction decreased to 3.89% and abnormal tympanograms dropped to 2.78%. Compliance improved from 71.11% showing normal values to 97.22% after treatment. Eustachian tube function also improved significantly, with normal function increasing from 51.11% to 95.56%, all with  $p < 0.001$ .

**Conclusion:** Treatment of sinonasal and nasopharyngeal masses significantly improves ET function, as indicated by the normalization of impedance audiometry findings.

**Keywords:** Eustachian tube, impedance audiometry, compliance, sinonasal and nasopharyngeal masses.

### Introduction

Historically, Bartholomaeus Eustachius (1513-1574) first detailed the anatomy and function of the Eustachian tube, while Antonio Valsalva (1666-1723) elaborated its structure and introduced the Valsalva manoeuvre for middle ear insufflation<sup>1</sup>.

The Eustachian Tube (ET) is an essential structure composed of a mucosa-lined canal, cartilage, peri-tubal muscles, and bony support, extending from the middle ear to the nasopharynx. It serves three primary functions: equalizing middle ear pressure with atmospheric pressure, clearing mucus, and protecting the middle ear from pathogens and debris<sup>2</sup>. The ET, middle ear, and mastoid air cells form a connected air-filled system within the temporal bone, maintaining communication with the nasal and nasopharyngeal spaces. Consequently, diseases from these areas can affect the middle ear through the ET<sup>3</sup>.

Middle ear function relies on the ET to manage pressure changes and maintain cleanliness through mucociliary transport. ET dysfunction can lead to tympanic membrane retraction, sterile effusion, and conductive hearing loss. Factors contributing to ET dysfunction include venous pressure changes, nasopharyngeal masses like hypertrophied adenoids, edema from inflammation or infection, and issues with mucociliary function or the ET's opening mechanism<sup>4</sup>.

Impedance audiometry is the most effective method for evaluating ET function, offering a comprehensive assessment of its anatomical patency and functional integrity<sup>5</sup>. This study investigates how sinonasal and nasopharyngeal masses affect ET function and whether treatment of these masses improves ET performance. Impedance audiometry was done 1 day

prior to initiating treatment and repeated at 2, 4 and 6 weeks after treatment (surgical or medical) to assess ET function.

**Materials and Methods**

- This is a prospective hospital-based study of ET dysfunction at a tertiary care centre in Central India.
- 90 study subjects were selected among the patients presenting to OPD in the department of Otorhinolaryngology. The patients presenting with sinonasal and nasopharyngeal masses were screened on basis of thorough history, clinical examination and relevant investigations including endoscopic evaluation, CT or MRI as and when required, and Biopsy if needed was done. Patients with history and examination s/o ET dysfunction were evaluated with impedance audiometry.
- The study was approved by Institutional Ethics committee for research work.
- Inclusion Criteria- Patients with nasopharyngeal/sinonasal masses with intact drum
- Exclusion Criteria
  - Patients with CSOM
  - Patients with history of previous nasal surgeries or ventilation tube insertion
- In patients with sinonasal and nasopharyngeal masses, impedance audiometry was carried out with Maico Impedance Audiometer before initiating treatment. Impedance audiometry was repeated at 2, 4 and 6 weeks after treatment. Tympanograms were classified as described by Jerger in 1975 in Clinical experience with impedance audiometry.

William’s test was performed to record middle ear pressure at rest, on swallowing and on Valsalva. Ambient middle ear pressure should be more than that on swallowing and less

than that on Valsalva and such a finding is noted as normal. If the middle ear pressure falls on swallowing but does not rise on Valsalva maneuver or vice versa, the function is considered to be partially impaired. If the middle ear pressure does not change at all either on swallowing or on Valsalva, the Eustachian tube function (ETF) is considered grossly impaired.

**Observations**

We studied a total of 90 patients in the age range of 5 to 74 years. Majority were in the age group of 15 to 24 years. Out of 90 patients selected, 60 (66.67%) patients were male and 30 (33.33%) patients female.

Maximum number of patients complained of nasal obstruction, i.e. 53 (58.89%) patients. Nasal discharge was seen in 36 (40%) patients, recurrent episodes of cough and cold in 32 (35.6%), nasal mass in 25 (27.78%), ear fullness in 20 (22.22%), nasal bleed in 12 (13.33%), headache in 11 (12.22%), earache in 5 (5.56%) and neck swelling in 1 patient (1.11%).

Out of 90 diseased patients, maximum cases, 40 (44.44%) patients were of antrochoanal polyposis. 23 (25.56%) cases had adenoid hypertrophy, 14 (15.56%) had ethmoidal polyposis, 8 (8.89%) had JNA, 3 (3.33%) had angiomatous polyp and 2 (2.22%) patients had Nasopharyngeal carcinoma.

**Comparison Between Pre and Post Treatment Picture:**

1. Otoscopy findings:

Before management, tympanic membrane was found to be retracted in 75 (41.67%) ears and normal in 105 (83.33%) ears. After management, retraction reduced to 7 (3.89%) ears and number of normal tympanic membranes increased to 173 (96.11%), with p-value <0.001 showing highly significant improvement in otoscopic picture of patients. (Table no. 1)

**Table No. 1:** Comparison of Otoscopy changes.

	Pre treatment		2 weeks		4 weeks		6 weeks		
	N	%	N	%	N	%	N	%	
Normal	45	50.0	52	57.78	75	83.33	85	94.44	$\chi^2=38.03$
Retraction	45	50.0	38	42.22	15	16.67	5	5.56	P<0.001 HS

2. Tympanometry:

Normal type A tympanogram was found in 126 (70%) ears and abnormal tympanogram was found in 54 (30%) ears before treatment. After treatment, 175 (97.22%) ears showed normal tympanogram and 5 (2.78%) ears showed

abnormal tympanogram. So, there was highly significant increase in the number of ears showing A type curve with p<0.001 for both right and left as per chi square test. (Table no. 2)

**Table No. 2:** Comparison of Tympanometry findings.

Side	Curve	Pre treatment		2 weeks		4 weeks		6 weeks		
		N	%	N	%	N	%	N	%	
Right	A	61	67.78	75	81.33	84	93.33	88	93.33	$\chi^2=38.74$ P<0.001 HS
	B	4	4.44	2	2.22	1	1.11	0	0	
	C	25	27.78	13	14.44	5	5.56	2	2.22	
Left	A	65	72.22	76	84.44	86	95.56	87	96.67	$\chi^2=34.84$ P<0.001 HS
	B	4	4.44	3	3.33	2	2.22	2	2.22	
	C	21	23.33	11	12.22	2	2.22	1	1.11	

3. Compliance:

Normal compliance was found in 128 (71.11%) ears and abnormal compliance in 52 (28.89%) ears before treatment. After treatment, 175 (97.22%) ears showed normal compliance and 5 (2.78%) ears showed abnormal

compliance. Thus, statistically highly significant improvement was observed in compliance of both right and left ears, with p<0.001 for each, as determined by chi square test. (Table no. 3)

**Table No. 3:** Comparison of Compliance.

	Pre treatment		2 weeks		4 weeks		6 weeks		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Right	0.46	0.22	0.60	0.20	0.71	0.22	0.80	0.19	102.22	<0.001 HS
Left	0.53	0.26	0.63	0.24	0.71	0.21	0.83	0.21	68.39	<0.001 HS

#### 4. Eustachian Tube Function test:

Impaired function was observed in 88 (48.89%) ears and normal function in 92 (51.11%) ears before treatment. After treatment, impaired function decreased to 8 (4.44%) ears

and normal function increased to 172 (95.56%) ears,  $p < 0.001$  implying highly significant improvement in eustachian tube function after treating sinonasal and nasopharyngeal masses. (Table no. 4)

**Table No. 4:** Comparison of Eustachian Tube Function.

		Pre treatment		2 weeks		4 weeks		6 weeks		Chi2-value/ p-value
		N	%	N	%	N	%	N	%	
Right	Normal	53	58.89	69	76.67	85	94.44	88	97.78	$\chi^2 = 62.09$ $P < 0.001$ HS
	Completely Impaired	24	26.67	10	11.11	2	2.22	1	1.11	
	Partially Impaired	13	14.44	11	12.22	3	3.33	1	1.11	
Left	Normal	39	43.33	61	67.78	81	91.01	93.33		$\chi^2 = 150.42$ $P < 0.001$ HS
	Completely Impaired	42	46.67	2	2.22	2	2.22	1	1.11	
	Partially Impaired	9	10.0	27	30.0	6	6.74	5	5.56	

## Discussion

When the eustachian tube (ET) mechanisms are compromised, it triggers a series of changes in the middle ear cleft, ranging from mild tympanic membrane (TM) retraction to severe conditions like cholesteatoma. Understanding the intricate mechanisms behind ET dysfunction, particularly in relation to sinonasal and nasopharyngeal diseases, remains a significant challenge.

In this study, higher prevalence was of males compared to females. Lazo et al<sup>6</sup> (2005), noted stronger correlations between ET function changes and nasal pathologies in children than adults. To avoid age as a confounding factor, this study ensured age homogeneity among participants.

Patients commonly reported nasal obstruction and discharge. Before treatment, 41.67% of ears had tympanic membrane retraction, consistent with Santosh et al.'s finding of retraction in 39.29% ears in sinonasal polyposis cases, and Chaudhary et al.'s<sup>7</sup> 50% incidence suggesting Eustachian tube (ET) dysfunction, though they did not include postoperative follow-up. Prior to treatment in the present study, 30% of ears had abnormal tympanograms, which dropped significantly to 2.78% post-treatment ( $p < 0.001$ ), mirroring improvements observed in other studies. For instance, Santosh B. Mane et al. saw a reduction from 50% to 19.04% in abnormal tympanograms, and Osama G. et al<sup>8</sup> (2014) noted significant improvements following nasal obstruction surgery ( $p < 0.05$ ). Andric-Filipovic et al.<sup>9</sup> found that inflammatory sinonasal diseases had a more pronounced effect on tympanograms than obstructive diseases, though ET functional tests remained unaffected by pathology type. In this study, compliance rates improved from 71.11% to 97.22% post-treatment, and ET function improved substantially, with impaired function dropping from 48.89% to 4.44% ( $p < 0.001$  for both). Osama G. et al (2014) similarly reported that postoperative ET function tests were significantly improved compared to preoperative results ( $p < 0.002$ ).

Salvinelli et al.<sup>10</sup> (2005) found that while Eustachian tube function improved after septal surgery, tympanometric findings did not change significantly pre- and post-operatively. However, our study found notable

improvements in both Eustachian tube function and tympanometric findings ( $p$ -value  $< 0.001$  for both) as assessed by impedance audiometry six weeks after surgery. Additionally, Yeolekar et al.<sup>11</sup> observed a 76.92% improvement in middle ear disease, including dry ear or closure of perforation, following polypectomy. Buchman et al.<sup>12</sup> have also highlighted a correlation between nasopharyngeal obstructive diseases and middle ear disorders. The dysfunction in sinonasal polyposis may result from mechanical obstruction at the pharyngeal end of the ET or inflammation due to allergic or infectious processes associated with polyposis, as suggested by Rajati et al.<sup>13</sup>

Eustachian tube dysfunction in nasal diseases may stem from mechanical obstruction by nasal masses or congenital anomalies, accumulation of secretions, acid reflux disease, lymphatic stasis from edema, increased hydrostatic pressure, or surfactant deficiency affecting tubal opening.

## Conclusion

Sinonasal and nasopharyngeal masses frequently cause ET dysfunction and removal of the same significantly improved Eustachian tube function 6 weeks after treatment.

## Declaration

Funding: None.

Conflict of interest: None declared.

Ethical approval: All procedures involving human participants were in accordance with the ethical standards of the institution.

Informed Consent: Informed consent was obtained from all individual participants included in this study.

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