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Effect of severity of Allergic Rhintis on tympanic membrane status: A Correlational Study

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Abstract: **Background:** Allergic rhinitis (AR) is a common inflammatory condition affecting the nasal mucosa and often associated with Eustachian tube dysfunction, which may influence middle ear status and tympanic membrane (TM) findings. **Objective:** To evaluate the correlation between tympanic membrane findings and the severity of allergic rhinitis among 246 patients. **Methods:** This cross-sectional observational study was conducted in a tertiary care center. A total of 246 patients diagnosed with allergic rhinitis were included. Severity of AR was classified based on ARIA guidelines into mild and moderate–severe categories. Otoscopic examination was performed to assess TM findings. Statistical analysis was done to determine correlation. **Results:** Among 246 patients, abnormal TM findings were significantly higher in moderate–severe AR patients ($p < 0.05$). Retraction and dull TM were the most common findings. A strong association was observed between severity of AR and middle ear changes. **Conclusion:** Increased severity of allergic rhinitis is significantly associated with abnormal tympanic membrane findings, suggesting the role of Eustachian tube dysfunction in AR.

Keywords: Allergic rhinitis, Tympanic membrane, Eustachian tube dysfunction, Otoscopy, ARIA classification.

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INTRODUCTION

Allergic rhinitis (AR) is an IgE-mediated inflammatory disorder of the nasal mucosa characterized by symptoms such as sneezing, rhinorrhea, nasal obstruction, and itching. It affects approximately 10–30% of the global population and significantly impacts quality of life [1]. Although allergic rhinitis is a long – term condition it is often not recognized in primary healthcare settings. Many people do not realize how much these allergic symptoms affect their daily life and overall quality of life [2]. After exposure to allergens patients commonly developed symptoms such as runny noes (rhinorrhea), nasal blockage, sneezing, and itching in the nose [3].

The anatomical and functional continuity between the nasopharynx and middle ear via the Eustachian tube makes the middle ear susceptible to changes in nasal pathology. Inflammation in allergic rhinitis may lead to Eustachian tube dysfunction (ETD), resulting in altered middle ear pressure and subsequent tympanic membrane (TM) changes. Allergic rhinitis is considered an important factor that can lead to Eustachian tube dysfunction. This dysfunction may further cause middle ear diseases such as acute otitis media, otitis media with effusion, and changes in the tympanic membrane (eardrum). Repeated or severe episodes of allergic rhinitis can increase the risk of Eustachian tube dysfunction and may affect both middle ear health and the condition of the eardrum [5].

The tympanic membrane serves as an accessible indicator of middle ear status and can reflect underlying Eustachian tube dysfunction. Common tympanic membrane findings associated with nasal and nasopharyngeal pathology include retraction, dullness, reduced mobility, altered light reflex, and in more severe cases, middle ear effusion. These otoscopic changes may occur more frequently and with greater severity in patients with moderate to severe allergic rhinitis [5].

The severity of allergic rhinitis is commonly assessed using standardized criteria such as the ARIA (Allergic Rhinitis and its Impact on Asthma) guidelines, which classify the disease based on symptom frequency, intensity, and impact on daily activities and sleep. Understanding the relationship between the severity of allergic rhinitis and associated tympanic membrane changes is clinically relevant, as early identification of middle ear involvement can help prevent complications such as otitis media with effusion and conductive hearing loss [6].

Despite the high prevalence of allergic rhinitis, limited studies have systematically evaluated the correlation between tympanic membrane findings and the severity of the disease. Establishing such a correlation would emphasize the importance of routine otoscopic examination in allergic rhinitis patient's early identification of otitis media with or without effusion which act as an early clinical window to detect subclinical conductive hearing loss, thereby done early intervention and to stop progression of diseases and contribute to a more comprehensive approach to patient management. Therefore, this study aims to correlate tympanic membrane findings with the severity of allergic rhinitis.

MATERIAL& METHODS

The present cross-sectional observational study was carried out in the Department of Otorhinolaryngology (ENT), People's Hospital. A total of 246 patients diagnosed with allergic rhinitis and attending the ENT outpatient department were included in the study after obtaining institutional ethical committee approval and written informed consent. Study was conducted from May 2024 to December 2025.

Study Variables

- **Independent variables:** Allergic rhinitis, demographic variables, occupation
- **Dependent variables:** Tympanic membrane status, pure tone audiometry findings, impedance audiometry results, and nasal endoscopic findings

Inclusion Criteria

- All newly diagnosed patients with allergic rhinitis attending the ENT outpatient department
- Patients aged **4 years and above**
- Patients who provided written and informed consent

Exclusion Criteria

- Patients below 4 years of age
- Patients with any history of ear disease preceding the onset of allergic rhinitis
- Patients with a history of previous ear or nasal surgery

Method of Data Collection

Data were collected using a structured proforma. Each patient underwent a detailed clinical evaluation, which included: Clinical history taking, Anterior rhinoscopy, Diagnostic nasal endoscopy, Otoendoscopic examination of the tympanic membrane, Impedance audiometry, Siegelization The severity of allergic rhinitis symptoms at presentation was recorded. On the same day, otoendoscopic examination of both ears was performed, and tympanic membrane findings were documented. Tympanic membrane status was categorized as normal or abnormal, including retraction (graded separately for pars tensa and pars flaccida), tympanosclerosis, features suggestive of serous otitis media, perforation, or chronic otitis media.

Statistical Analysis: The collected data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) software (Version 26.0). Appropriate statistical tests were applied to evaluate the association between the severity of allergic rhinitis and tympanic membrane findings. A p-value of less than 0.05 was considered statistically significant.

RESULT

The present cross-sectional observational study was carried out among 246 patients diagnosed with allergic rhinitis. The majority belonged to the 21–30 years age group, accounting for 74 cases (30.1%). This was followed by the 31–40 years group with 56 patients (22.8%) and the 11–20 years group with 52 patients (21.1%). Mean age of allergic rhinitis patients was 28.40 Year. This shows that allergic rhinitis predominantly affects young adults. Out of the total 246 patients, males constituted 138 cases (56.1%), whereas females accounted for 108 cases (43.9%). The male-to-female ratio was approximately 1.3:1. This mild male predominance suggests that allergic rhinitis is slightly more common in males.

Based on ARIA classification, moderate-to-severe persistent allergic rhinitis was the most common category, seen in 82 patients (33.3%). Mild persistent allergic rhinitis was observed in 62 cases (25.2%), while mild intermittent disease was present in 54 patients (22.0%). Moderate-to-severe intermittent allergic rhinitis was noted in 48 patients (19.5%). Overall, nearly half of the patients (52.8%) had persistent disease, indicating chronic symptomatology. (Table1)

Tympanic membrane examination revealed abnormal findings in 144 patients (58.5%), while 102 patients (41.5%) had a normal tympanic membrane. The most common abnormality was retracted tympanic membrane, seen in 86 cases (35.0%). This was followed by dull tympanic membrane in 32 patients (13.0%) and congested tympanic membrane in 18 patients (7.3%).

Tympanic membrane effusion was seen in 8 patients (3.2%), indicating Eustachian tube dysfunction.(Table2) Table 3 reveals correlation Between Severity of Allergic Rhinitis and Tympanic Membrane Findings. Among patients with mild allergic rhinitis (n = 116), 68 patients had normal tympanic membranes, whereas in moderate-to-severe allergic rhinitis (n = 130), only 34 patients had normal findings. Retracted and dull tympanic membranes were significantly more common in moderate-to-severe cases. Tympanic membrane effusion was observed exclusively in moderate-to-severe allergic rhinitis (8 cases). This association was statistically significant ($p < 0.001$), showing increasing ear involvement with increasing disease severity. There was statistically highly significant correlation was found between allergic rhinitis and tympanic membrane findings.

Table 4 reveals Correlation Between Nasal Symptoms and Tympanic Membrane Changes. Patients presenting with nasal obstruction showed tympanic membrane abnormalities in 96 out of 124 cases, followed by sneezing in 84 out of 130 cases. Rhinorrhea was associated with tympanic membrane changes in 78 patients, while nasal itching showed fewer abnormalities (42 cases). The correlation between nasal symptoms and tympanic membrane changes was statistically significant. This suggests that more severe nasal symptoms are associated with higher ear involvement. There was statistically highly significant correlation found between Nasal Symptoms and Tympanic Membrane Changes ($P<0.001$).

Table 5 reveals Distribution of Tympanic Membrane Effusion According to Severity of Allergic Rhinitis. Tympanic membrane effusion was noted in 8 patients, all of whom belonged to the moderate-to-severe allergic rhinitis group. None of the patients with mild allergic rhinitis showed middle ear effusion. Among 130 patients with moderate-to-severe disease, 8 (6.2%) had effusion, compared to 0% in mild cases. This association was statistically significant , highlighting the role of disease severity in middle ear pathology. There was statistically significant association found between Tympanic Membrane Effusion According to Severity of Allergic Rhinitis. ($P=0.006$)

Table-1: Severity of Allergic Rhinitis Based on ARIA Classification.

Severity of Allergic Rhinitis	Number (N)	Percentage (%)
Mild Intermittent	54	22.0
Mild Persistent	62	25.2
Moderate–Severe Intermittent	48	19.5
Moderate–Severe Persistent	82	33.3
Total	**246**	**100**

Table-2: Tympanic Membrane Findings in Patients with Allergic Rhinitis

Tympanic Membrane Finding	Number (n)	Percentage (%)
Normal	102	41.5
Retracted TM	86	35.0
Dull TM	32	13.0
Congested TM	18	7.3
Tympanic membrane effusion	8	3.2
Total	**246**	**100**

Table 3: Correlation Between Severity of Allergic Rhinitis and Tympanic Membrane Findings

TM Finding	Mild AR (n=116)	Moderate– Severe AR (n=130)	Total	Chi Square Value	P value
Normal	68	34	102	**32.464**	**<0.001* Highly Significant**
Retracted	34	52	86		
Dull	10	22	32		
Congested	4	14	18		
Effusion	0	8	8		
Total	**116**	**130**	**246**		

Table4: Correlation Between Nasal Symptoms and Tympanic Membrane Changes

Predominant Symptom	TM Abnormality Present	TM Normal	Total N=246	Chi Square Value	P value
Sneezing	84	46	130	**22.8930**	**<0.001* Highly Significant**
Nasal obstruction	96	28	124		
Rhinorrhea	78	34	112		
Nasal itching	42	48	90		

Table-5: Distribution of Tympanic Membrane Effusion According to Severity of Allergic Rhinitis

Severity	Effusion Present	Effusion Absent	Total	Chi Square Value	P value
Mild AR	0	116	116	**7.378**	**0.006* Significant**
Moderate–Severe AR	8	122	130		
Total	**8**	**238**	**246**		

DISCUSSION

Demographics

The present study demonstrates that allergic rhinitis predominantly affects the younger population, with the highest incidence observed in the 21–30 years age group (30.1%), followed by the 31–40 years (22.8%) and 11–20 years (21.1%) groups. The mean age of the study population was 28.40 years, indicating that young adults form the major affected demographic. These findings are in agreement with several previous studies by Baba Caliaperoumal V *et al.* [5] reported that allergic rhinitis was most common in the second and third decades of life, supporting the predominance of younger age groups. However, some studies show contrasting findings. A study by Sahay N *et al.* [6] reported a relatively higher prevalence in adolescents and pediatric age groups, suggesting earlier onset of symptoms.

The present study shows a slight male predominance in allergic rhinitis, with males accounting for 56.1% of cases compared to 43.9% in females, resulting in a male-tofemale ratio of approximately 1.3:1. These findings are consistent with several previous studies by Baba Caliaperoumal V *et al.* [5] & Modwal A *et al.* [7] who observed that males were slightly more affected than females, which supports the present study findings. The variation in gender distribution across studies may be attributed to geographical differences, environmental exposure, lifestyle factors, and healthcare access patterns. Despite these differences, most studies, including the present one, agree that allergic rhinitis affects both sexes substantially.

Allergic Rhinitis Severity

In a comparative analysis, the present study evaluated 246 patients with allergic rhinitis and found that the majority were classified under the moderate–severe persistent category (33.3%), followed by mild persistent (25.2%), mild intermittent (22.0%), and moderate–severe intermittent (19.5%). Overall, persistent forms (both mild and moderate–severe) predominated over intermittent forms, indicating a higher burden of chronic disease in the study population.

These findings are in concordance with previous studies based on ARIA classification, where moderate–severe persistent allergic rhinitis has consistently been reported as the most common subtype.For instance, a European study reported a much higher proportion of moderate–severe persistent cases (51.2%), followed by moderate–severe intermittent (41.8%), while mild intermittent (3.9%) and mild persistent (3.1%) cases were comparatively fewer. Similarly, the study conducted by Lee CH *et al.* [8] demonstrated a comparable distribution, with moderate–severe persistent cases accounting for 34.7%, followed by mild intermittent (27.4%), mild persistent (20.8%), and moderate–severe intermittent (17.1%). However, some studies show contrasting results. A study by Patel M *et al.* [9] reported that intermittent allergic rhinitis was more common, especially in regions where seasonal allergens predominate.

The predominance of persistent forms in the present study may be explained by continuous exposure to indoor allergens (dust mites, molds), environmental pollution, and delayed healthcare-seeking behavior, leading to chronicity and increased severity.

Tympanic Membrane finding

In the present study, otoscopic examination revealed that a normal tympanic membrane (TM) was observed in 41.5% of patients, while 35.0% showed retracted TM. Other findings included dull TM in 13.0%, congested TM in 7.3%, and tympanic membrane effusion in 3.2% of cases.

In comparison, the study conducted by Kumar S *et al.* [10] reported a significantly higher proportion of normal TM (78.30%) and a much lower incidence of retracted TM (8.30%). This indicates that abnormal TM

findings, particularly retraction, were more prevalent in the present study population. However, some studies show contrasting findings. A study by Nguyen LH *et al*. [11] reported that the majority of allergic rhinitis patients had normal tympanic membranes, suggesting minimal middle ear involvement in certain populations. Similarly, Alles R *et al*. [12] found a lower incidence of TM abnormalities, with effusion and retraction being relatively uncommon.

Nasal Symptoms

Allergic rhinitis is characterized by one or more symptoms that include sneezing, itching, nasal congestion, and rhinorrhea. Mucosal inflammation in allergic asthma and rhinitis is characterized by tissue eosinophilia [13]. This was also seen in the study by Ravi *et al*., [14] which depict nasal smear eosinophilia as more prevalent in allergic rhinitis.

The present study demonstrates a highly significant association between predominant nasal symptoms and tympanic membrane ™ abnormalities ($\chi^2 = 22.893$, $p < 0.001$), with nasal obstruction (77.4%) and rhinorrhea (69.6%) showing the strongest correlation. Studies by Caliaperoumal *et al*. [15] and Dharanya GS *et al*. [16] have similarly highlighted that symptoms such as nasal blockage and discharge are significantly associated with abnormal otological findings, including TM retraction and effusion. In contrast, symptoms like nasal itching, which are more purely allergic in nature, have shown weaker associations with middle ear pathology, aligning with the present study where only 46.7% of patients with nasal itching had TM abnormalities.

However, some studies have reported contrasting findings. A study by Skoner DP *et al*. [17] suggested that although allergic rhinitis is associated with nasal symptoms, the correlation with middle ear pathology is not always significant, and many patients with prominent nasal obstruction may still have normal tympanic membranes.

Association between the severity of allergic rhinitis (AR) and tympanic membrane (TM): The present study demonstrates a highly significant association between the severity of allergic rhinitis (AR) and tympanic membrane (TM) findings ($\chi^2 = 32.464$, $p < 0.001$), with abnormal TM findings being more prevalent in the moderate–severe AR group. Normal TM was predominantly observed in mild AR patients (68/116), whereas retracted TM (52/130), dull TM (22/130), congested TM (14/130), and middle ear effusion (8/130) were more frequently seen in moderate– severe AR cases, indicating a clear trend of increasing middle ear involvement with increasing disease severity. These findings are consistent with previous studies which have shown that worsening severity of allergic rhinitis is associated with greater Eustachian tube dysfunction and subsequent middle ear changes**.** Caliaperoumal *et al*. [15] reported that increased severity of sinonasal inflammation correlates with higher incidence of abnormal otological findings, including TM retraction and effusion. Similarly, studies by Zhang *et al*. [18] and Doyle WJ [19] have demonstrated that patients with moderate to severe allergic rhinitis exhibit significantly impaired Eustachian tube function, predisposing them to middle ear effusion and TM changes.

However, some studies have reported contrasting findings. A study by Skoner DP *et al*. [17] suggested that the severity of allergic rhinitis does not always correlate directly with middle ear changes, and even patients with mild disease may occasionally exhibit TM abnormalities. Similarly, Alles R *et al*. [12] found no consistent relationship between AR severity and otological findings, indicating that factors such as genetic predisposition, environmental exposure, and host immune response may influence middle ear involvement independently of disease severity.

Thus, while the present study strongly supports that increasing severity of allergic rhinitis is associated with greater tympanic membrane abnormalities, the presence of conflicting evidence indicates that the relationship is complex and multifactorial, influenced by additional host and environmental factors. Thus, while the present study and several previous studies support a significant association between TM abnormalities and moderate–severe persistent AR, the presence of conflicting evidence indicates that this relationship is not uniform and may be influenced by multiple host and environmental factors.

Association between the severity of allergic rhinitis (AR) and middle ear effusion

The present study shows a statistically significant association between the severity of allergic rhinitis (AR) and the presence of middle ear effusion ($\chi^2 = 7.378$, $p = 0.006$), with effusion observed exclusively in patients with moderate–severe AR (8/130), while no cases were seen in mild AR (0/116). This finding suggests that increasing severity of AR predisposes patients to middle ear effusion, likely due to progressive Eustachian tube dysfunction caused by persistent mucosal edema and inflammation. Similar observations have been reported in previous studies. Zhang *et al*. [18] demonstrated that patients with moderate to severe allergic rhinitis have significantly impaired Eustachian tube function, increasing the risk of middle ear effusion. However, some studies have reported contrasting results. A study by Skoner DP *et al*. [17] found that middle ear effusion can occur even in mild allergic rhinitis, suggesting that severity may not be the only determining factor.

Thus, while the present study strongly supports that middle ear effusion is predominantly associated with moderate–severe allergic rhinitis, the presence of conflicting evidence suggests that the relationship is not

absolute and may be influenced by additional factors beyond disease severity.

CONCLUSSION

Overall, the study establishes that both the severity and symptom profile of allergic rhinitis play a crucial role in the development of middle ear changes. These findings underscore the importance of routine otological evaluation in patients with allergic rhinitis, particularly in those with moderate to severe disease, for early detection and prevention of complications related to Eustachian tube dysfunction leading to various middle ear pathologies. Hence, a proper otological examination including eustachian tube patency should be done in all cases of allergic rhinitis.

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