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PREVALENCE OF EUSTACHIAN TUBE DYSFUNCTION IN ALLERGIC RHINITIS: A CROSS SECTIONAL STUDY AT A TERTIARY CARE CENTRE IN NEPAL

ABSTRACT

Aims and Objectives: This study investigates the prevalence of Eustachian tube dysfunction in patients with AR by assessing tubal health and analyzing tympanometry findings. It specifically examines how nasal symptoms contribute to tubal impairment.

Methods: This descriptive cross-sectional observational study was conducted at Nepal Medical College Teaching Hospital over 12 months. Ninety patients diagnosed with allergic rhinitis were recruited using purposive sampling. Subjective assessment was performed using the 7-item Eustachian Tube Dysfunction Questionnaire, while objective evaluation included otoscopy and tympanometry.

Results: Out of 90 cases, there was highest frequency of patients aged 15-25 years with no gender predilection. Students and housewives were the most prevalent occupation (26.7% and 22.4% respectively). The prevalence of Eustachian tube dysfunction was 31.1%. Nasal obstruction and Eustachian tube dysfunction questionnaire score were statistically significant factors for Eustachian tube dysfunction (p value 0.04 and 0.001 respectively).

Conclusion: Nasal obstruction is an important factor for development of Eustachian tube dysfunction in patients with allergic rhinitis. Scoring system can possibly be used as a screening tool for assessment of tubal pathology in patients with allergic rhinitis.

Keywords: Allergic rhinitis; Eustachian tube; Eustachian tube dysfunction questionnaire score; Tympanometry.

INTRODUCTION

Allergic rhinitis (AR) is an inflammation of nasal mucosal membranes brought about by Immunoglobulin E (IgE) mediated inflammatory response after exposure to allergens.[1] Allergic rhinitis has a higher prevalence of Eustachian tube dysfunction (ETD) which is detected by tympanometry. Eustachian tube (ET) plays an important role in conducting middle ear pressure with that of atmospheric pressure. Derangement of ET function thereby initiates pathophysiologic changes, marked by Eustachian tube obstruction which may either be due to allergic process or infection related inflammation.[2]

Several studies have confirmed genetic heritability of AR. Having parents who are atopic may increase the risk of a child having an allergic disease by three to six times.[3] Environmental variables are crucial since sensitivity does not develop without exposure to an allergen. Before the age of two years, pollen-induced allergic rhinitis is uncommon, indicating that sensitization requires exposure across two seasons.[4]

The ET extends from an opening on the anterior wall of the middle ear to an opening in the nasopharynx just posterior to the inferior nasal concha and lateral to the adenoid pad.[5] Histologically, the mucosal lining displays a pseudostratified ciliated columnar epithelium interspersed with goblet cells that secrete mucus. The cilia beat in the direction of nasopharynx and thus help to drain secretions and fluid from the middle ear into the nasopharynx.[6]

ET ventilates and clears fluid from the middle ear when open, and prevents transmission of pathogenic material, and sounds when closed. Eustachian tube dysfunction (ETD) is a common diagnosis applied to conditions where the Eustachian tube is incapable of performing its functions adequately.[7] The patients with ETD usually presents with symptoms like aural fullness or popping or discomfort/pain. Patients may also report pressure, clogged or under water sensation, crackling, ringing, autophony and muffled hearing.[8]

The Eustachian Tube Dysfunction Questionnaire-7 (ETDQ-7) is a validated seven-item questionnaire designed to quantitatively assess subjective ETD symptoms. By converting clinical observations into a measurable score, it provides a more reliable assessment than traditional clinical history. Prior studies suggest a total score 14(or a mean > 2.1) as the diagnostic cutoff, indicating significant ETD.[9]

Over the past 1 month, how much has each of the following been a problem for you	No problem		Moderate problem			Severe problem	
1. Pressure in the ears?	1	2	3	4	5	6	7
2. Pain in the ears?	1	2	3	4	5	6	7
3. A feeling that your ears are clogged or 'under water'?	1	2	3	4	5	6	7
4. Ear symptoms when you have a cold or sinusitis?	1	2	3	4	5	6	7
5. Crackling or popping sounds in the ears?	1	2	3	4	5	6	7
6. Ringing in the ears?	1	2	3	4	5	6	7
7. A feeling that your hearing is muffled?	1	2	3	4	5	6	7

Figure 1. Eustachian tube dysfunction questionnaire.[9]

METHODS

The descriptive study was conducted in patients presenting to Otorhinolaryngology outpatient department of Nepal Medical College and Teaching Hospital, Jorpati, Kathmandu from November 2021 to October 2022. Permission was obtained from ethical committee. Ninety patients with features of AR who were seven years and older were chosen. The information included demographic data such as age, gender, occupation. Detailed history, a complete ear, nose and throat, head and neck examination, ETDQ-7 questionnaire assessment, tympanometry and symptom severity assessment were done at Otolaryngology outpatient department.

Patients aged 7 years and above with symptoms of allergic rhinitis such as nasal obstruction, sneezing, watery nasal discharge and nasal itching were included in the study. Similarly, patients with congenital ear anomalies, palatal malformations, Trisomy 21, pre-existing acute or chronic otitis media, a history of middle ear surgery, age below 7 years, or unwillingness to provide voluntary consent were excluded from the study.

Appearance of nasal mucosa as bluish pale or boggy with thin watery nasal discharge was considered as characteristic examination finding in AR cases. Otoscopic examination was performed to mainly visualize retraction of tympanic membrane. A 512Hz tuning fork was used to assess Rinne and Weber test in these individuals. Participants enrolled were sent to audiologist for impedance audiometry. Tympanometry findings was recorded as Type B/C which was considered significant for this study and non-Type B/C. Acquiring Type B/C curve in either ear of the participant was considered as having Eustachian tube dysfunction.

All the data were entered in a standard proforma. Further, the data were compelled into Microsoft excel format 2010 and statistical analysis was done with Statistical Package for the Social Sciences (SPSS) version 16. Informed consent was taken from every patient for the study. The study was conducted after patient approval.

The sample size was calculated using following formula: N=.

Where, N= total number of samples, z=95% confidence interval i.e., 1,96, p= prevalence, q=1-p and d=allowable error i.e., 10% for this study.

We considered p=28.2% which is the prevalence of allergic rhinitis as found from a survey done in Kathmandu in year 2009 to 2010 in another study with allowable error of and level of confidence 95%. Based on these parameters, the minimum sample required was 77. However, we included 90 patients for this study.

Descriptive statistical tests were used and the data were analysed using SPSS version 16. Results were expressed in numbers and percentages.

RESULTS

A total number of 90 cases with AR were included in the study. The demographic distribution of these patients is detailed in Table 1. The highest frequency of AR was observed in the 15-25 age group.

Table 1. Demographic distribution (N=90)

Category	Sub category	Frequency	Percentage
Gender	Male	45	51.1%
	Female	45	48.9%
Age(years)	16-25	33	33.33%
	26-35	26	25.56%
	36-45	22	22.22%
	>45	15	14.4%
Occupation	Students	24	26.7%.
	Homemaker	20	22.2%
	Business	8	8.9%
	Painter	8	8.9%
	Farmer	6	6.7%
	Other	24	26.4%

Four major nasal symptoms were studied in 90 patients, symptoms were led by sneezing (94.4%, n=85), followed by rhinorrhea (92.2%, n=83) and nasal obstruction (85.5%, n=77), with nasal itching being the least frequent (71.1%, n=64).

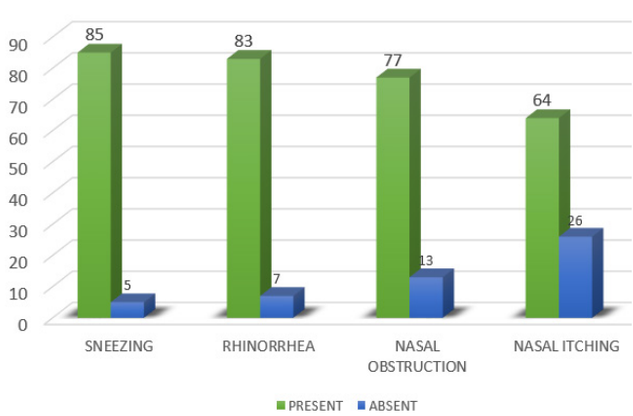


Figure 2. Major nasal symptoms (N=90)

Eustachian tube dysfunction questionnaire was used to evaluate the aural symptoms in patients with AR. Using a cutoff of 14 (indicating normal function), 61.1% (n=55) of the 90 patients scored ≥14 while 38.9% (n=35) scored <14. The mean ETDQ-7 score was 12.71±4.689.

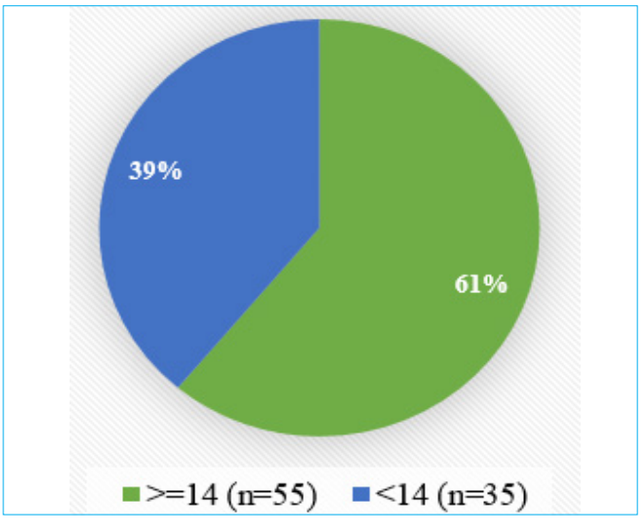


Figure 3. Eustachian tube dysfunction questionnaire

On otoscopic examination, out of 90 patients 52.20% (n=47) had abnormality in their right ears and 55.6% (n=50) had abnormality in their left ears. Remaining had normal findings on otoscopy. Abnormal otoscopic findings included retracted tympanic membrane but excluded perforated tympanic membrane.

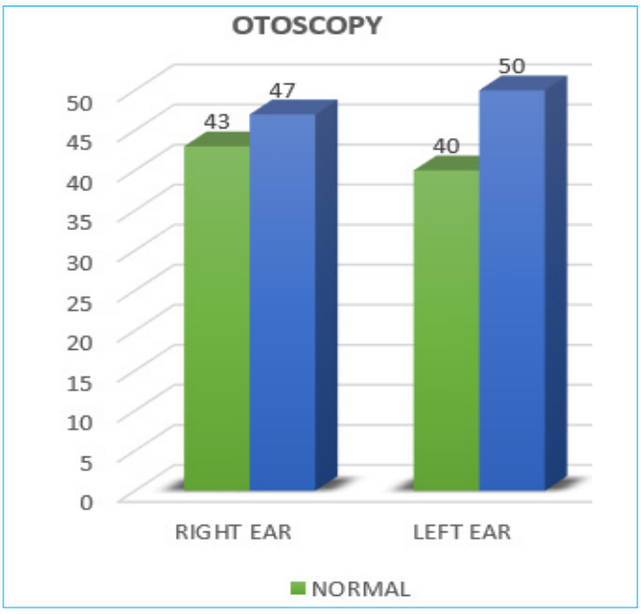


Figure 4. Otoscopy findings of the patients (N=90)

On performing objective test tympanometry, 25.5% (n=21) of the patients with allergic rhinitis had either Type B or C curve on tympanometry in their right ears. Similarly, 24.4% (n=22) had either Type B or C curve on tympanometry in their left ears. Rest had other types of curves on tympanometry. Either type B or C curves on tympanometry is suggestive of ET dysfunction.

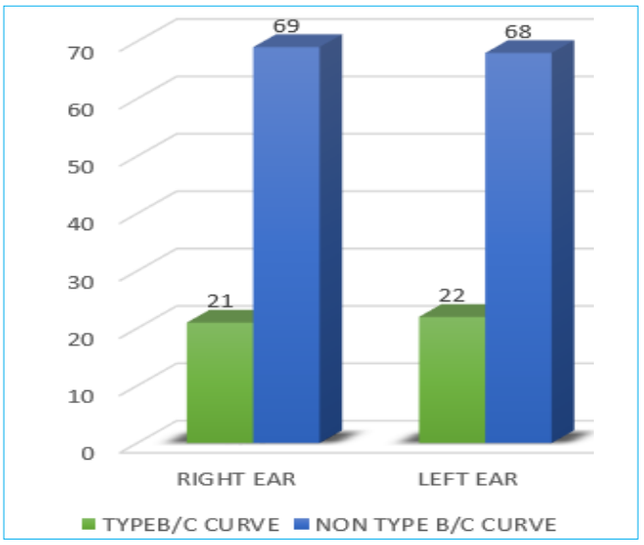


Figure 5. Tympanometry findings of the patients

The prevalence of ET dysfunction in the patients with allergic rhinitis which was found to be 31.10% (n=28). The mean ETDQ-7 score obtained was 12.71±4.689. Out of 90 patients included in the study, 28 had Eustachian tube dysfunction as indicated by Type B or C curve on tympanometry.

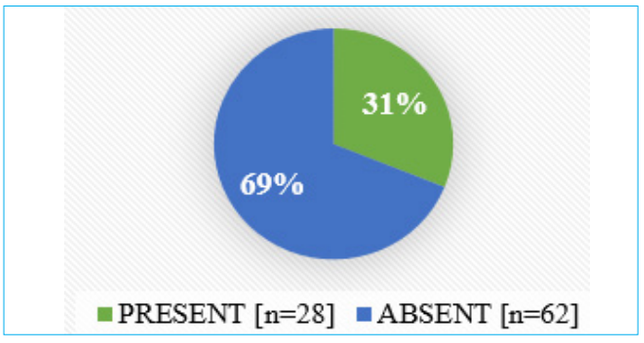


Figure 6. Prevalence of ET Dysfunction.

While most allergic rhinitis symptoms were present in patients with ETD, nasal obstruction was the only statistically significant predictor (p = 0.04). Patients with nasal obstruction faced 6.48 times higher odds of developing ETD.

Table 2. Allergic rhinitis symptoms with ETD

Symptoms		ETD		P value*	OR
		Absent	Present		
Sneezing	Absent	3	2	0.65	0.66
n=85	Present	59	26		
Rhinorrhea	Absent	5	2	0.88	1.14
n=83	Present	57	26		
Nasal obstruction	Absent	12	1	0.04	6.48
n=77	Present	50	27		
Nasal itching	Absent	19	7	0.58	1.32
n=64	Present	43	21		

**Chi- square test, *Odds ratio*

Of the 28 patients with abnormal tympanometry (Type B or C), 92.8% (n=26) scored ≥14 on the ETDQ-7, showing a significant correlation between aural symptoms and pressure findings (p = 0.001, 95% CI).

Table 3. ETDQ with tympanometry (N=90).

ETDQ Score	Tympanometry		p-value
	Non Type B/C	Type B/C	
≥14	33	2	
<14	29	26	0.001
Total	62	28	

**Chi square test*

Further the findings were subjected to Receiver Operated Characteristic (ROC) curve as shown below considering ETDQ score as test variable and ET dysfunction as result variable.

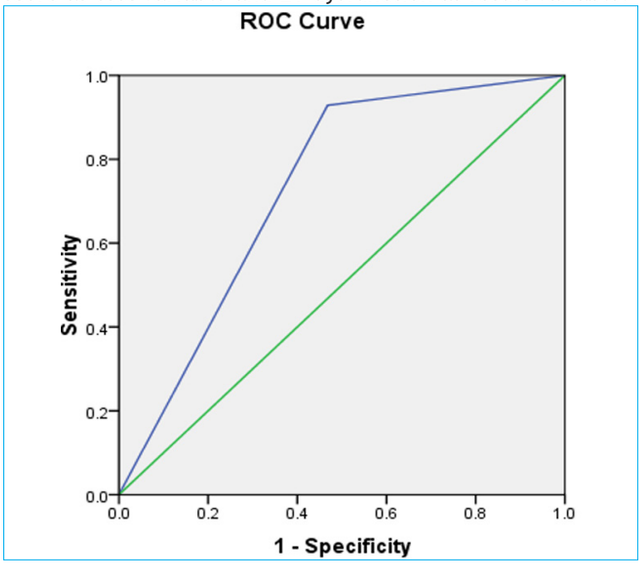


Figure 7. ROC for ETDQ score and ET dysfunction

The Area under the curve (AUC) in the above ROC curve is 73% with a sensitivity of 92.9%, specificity of 53.2% and 1-Specificity of 46.8%. The finding suggests that using ETDQ in determining the probability of ET dysfunction in cases of allergic rhinitis has high sensitivity of 92.9% but a low specificity of 53.2%.

DISCUSSION

Despite being a frequent complication of nasal inflammation and infection, the prevalence of ETD remains poorly quantified due to limited assessment tools.[10] This study aimed to determine ETD prevalence in AR patients by evaluating Eustachian tube performance and identifying how primary symptoms such as obstruction, itching, discharge, and sneezing contribute to the condition.[11] Additionally, the research utilized tympanometry to analyze middle ear findings specifically within the AR population. AR was clinically diagnosed based on persistent nasal stuffiness, watery discharge, itching, and sneezing. To meet the criteria, symptoms had to occur for over an hour on most days for at least two consecutive days.[10] Eustachian tube dysfunction questionnaire is a patient reported scoring system of ear related symptoms to assess severity of ETD and it has been used since 2012.[11] This questionnaire provides scoring system as 1 to 2 for no problem, 3 to 5 for moderate problem and 6 to 7 for severe problem.[2]

The eustachian tube plays a key role in middle ear function by regulating air pressure inside the ear with atmospheric pressure. This disruption is linked to the pathophysiologic alterations that lead to eustachian tube obstruction, which are primarily brought on by allergy or infection-related inflammatory processes. Epidemiologic studies in many countries showed that 50% of patients having otitis media also had AR and 21% of patients having AR also developed otitis media which is the most common cause of hearing impairment and speech impairment in children.[2]

Tympanometry objectively assesses middle ear pressure, canal volume, and Eustachian tube function. Results are classified as Type A: Normal, Type B (Flat): Indicates fluid or cerumen (if the eardrum is intact), Type C (Negative Pressure): Indicates eardrum retraction. Excluding perforations, Type B and Type C are diagnostic of ETD.[2]

In our study of 28 patients (10 males, 18 female) and a 2020 study by Ma et al.[11] of 59 patients (27 males, 32 female), showed the p-values were 0.069 and 0.57 respectively. Since both p- values exceed 0.05, gender is not a statistically significant factor in the development of ETD among those with AR. The higher female prevalence in our study likely reflects increased exposure to domestic triggers like kitchen fumes, mold, and dust mites.

Our study and research by Nepali et al.[12] both identify students and homemakers as the primary groups affected by Allergic Rhinitis (AR). This prevalence is attributed to high exposure to specific environmental triggers: students are frequently exposed to chalk dust, while homemakers encounter kitchen fumes and indoor pollutants. Common allergens found in domestic settings such as house dust mites in carpets and bedding serve as the most significant contributors to AR within these demographics.

In our study, 61.1% of AR patients tested positive for ETD using the ETDQ-7 (score≥14), yielding a sensitivity of 92.9% and specificity of 53.2%. While these results align with the high sensitivity (91–100%) reported in the 2021 systematic review by Nicholas et al.[14] our study showed lower specificity compared to previous findings by Teixeira et al. (78%) and Nicholas et al. (67–100%). This lower diagnostic accuracy may stem from our smaller sample size or the fact that conditions like temporomandibular joint disorders, Meniere's disease, and dental pathology can mimic ETD symptoms. Ultimately, the ETDQ-7 remains a highly sensitive tool for identifying

subjective features like aural fullness and tinnitus, though its specificity is limited by symptomatic overlap with other disorders.

Our study found that nasal obstruction is a statistically significant factor in the development of ETD, with 27 out of 28 affected subjects showing abnormal Type B/C tympanograms ($p = 0.04$). These results are consistent with findings by Ma et al.[11] and Nudrat et al.[14], both of whom reported significant correlations ($p = 0.019$ and $p = 0.0001$, respectively) between persistent nasal obstruction and ETD. This suggests that chronic symptoms of AR, specifically obstruction, may lead to irreversible ETD. The high prevalence of this association is likely due to concurrent factors such as inferior turbinate hypertrophy, deviated nasal septum and edema of the torus tubarius.

Our study found an ETD prevalence of 31.10% among patients with AR, a result comparable to the 37.3% reported by Ma et al.[11] in 2020, likely due to similar sample sizes and age groups. In contrast, Lazo et al.[2] (2002) found a lower prevalence of 15.5% in a larger pediatric-only study. Additionally, a massive study by Thakur et al.[15] (2014) identified ETD in 12.89% of over 15,000 subjects, reinforcing that nasal allergy is a primary inciting factor for the condition. These variations highlight how sample size, age demographics, and the presence of AR significantly influence ETD prevalence rates.

In our study, 26 of the 55 cases with an ETDQ-7 score ≥14 demonstrated a Type B/C tympanogram, compared to only 2 cases with a score < 14. The correlation between high ETDQ-7 scores and objective tympanometry findings was statistically significant ($p = 0.001$). This mirrors findings by Ma et al.[11] ($p = 0.005$), where 37.3% of patients with allergic rhinitis showed both high symptom scores and abnormal tympanograms. These results suggest that persistent subjective symptoms such as aural fullness, earache, and tinnitus highly correlate with objective negative middle ear pressure (Type B/C curves), confirming the presence of Eustachian tube pathology.[16]

Our study found the ETDQ-7 had a diagnostic sensitivity of 92.8% and specificity of 53.2% with an AUC of 0.73, results that align closely with Miriam et al.[17], who reported an AUC of 0.72. Despite varying objective measures tympanometry versus pressure equilibration both studies indicate that diagnostic accuracy is somewhat limited by the subjective nature of the questionnaire. Consequently, the ETDQ-7 is best utilized as an effective screening tool for identifying ETD in patients with AR

CONCLUSION

Eustachian tube dysfunction affects nearly one-third of AR patients in this study. Nasal obstruction is the primary clinical driver of this dysfunction, and the ETDQ-7 is a highly effective tool for its subjective assessment.

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