ORIGINAL RESEARCH PAPER

Otorhinolaryngology

KEY WORDS: Allergic Rhinitis, Otitis Media With Effusion, Eustachian Tube Dysfunction.

A CROSS - SECTIONAL STUDY OF OTOLOGICAL CHANGES IN ALLERGIC RHINITIS

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ABSTRACT

Background: Aim of this study was to investigate otological changes linked to allergic rhinitis, assessing ARIA score distribution, impact on tympanic membrane , and middle ear pressure correlation with rhinitis duration. **Methods:** A cross-sectional, observational study over a period of one year, total 130 patients with nasal obstruction, sneezing, and itching who provided written informed consent. Patients with allergic rhinitis were assessed through history, clinical examination, and diagnostic nasal endoscopy. Patients with positive anterior rhinoscopy findings or deviated nasal septum or hypertrophied inferior turbinate were diagnosed. Tympanometry was performed for all patients. **Results:** The study examined the distribution of patients with allergic rhinitis and its effects on asthma (ARIA). The majority of patients were aged 31-40 years, with 70% being male. Duration of the disease varied, with 26.92% having a duration less than a year. The frequency of mild, moderate, and severe ARIA was 63.08%, 20.00%, and 16.92%, respectively. Complications in the right ear were 23.85%, while in the left ear it was 16.15%, 27.69%, 3.85%, 1.54%, and 2.31%. The distribution was based on pars flaccida grades, tympanic membrane mobility, and tuning fork tests. The ARIA classification showed that 67.07% of 82 patients experienced intermittent ear symptoms. The correlation between mean middle ear pressure and ARIA classification was found to be significant. The duration of allergic rhinitis varied from <1 year to >10 years, with varying degrees of pressure on the right and left ear. Middle ear pressure decreased significantly with disease duration in both ears, indicating a significant impact on the condition. **Conclusion:** Allergic rhinitis can lead to otologic abnormalities, such as Eustachian tube dysfunction, otitis media, middle ear effusion, changes in the tympanic membrane, and increased vulnerability to otitis externa.

INTRODUCTION

Allergic rhinitis is an inflammatory nasal mucosa disease caused by an enhanced IgE-mediated immune response to inhaled allergens, affecting 10-25% of the global population.[1,2] Common allergens include molds, dust mites, pollens, and pets. Other allergic diseases include asthma, rhinosinusitis, otitis media, nasal polyposis, allergic conjunctivitis, and recurrent lower respiratory tract infections.[3,4] Symptoms include sneezing, runny nose, nasal irritation, and obstruction or congestion. Allergic reactions are most commonly affected in the region with Hansel documenting symptoms in the nose in 1936. The disease is a global problem and one of the top 10 causes of primary healthcare utilization.[5]

Allergy-related rhinitis, categorized as mild, moderate/ severe, intermittent, and chronic, can significantly impact patients quality of life and overall well-being.[6-9] Nasal cytology, a non-invasive technique, can help examine the changes in the nasal mucosa in individuals with allergic rhinitis.[10] This method helps determine the type and amount of inflammatory cells present in the mucosa. A study in India revealed that patients with allergic rhinitis had more eosinophils and mast cells in their nasal cytology and significantly impaired middle ear function, suggesting nasal cytology can provide insight into the development and symptoms of this condition.[11]

Otitis media with effusion (OME) is a fluid buildup in the middle ear that can cause hearing loss and ear pain. It is linked to allergic rhinitis, with children at a higher risk. Intranasal corticosteroids have been found to decrease OME incidence in children.[12,13] The exact mechanism behind this link is unclear, but theories suggest fluid accumulation may be due to inflammation of the Eustachian tube or immune system changes. Further research is needed to develop effective preventive and therapeutic measures.[14]

Numerous studies have explored the link between allergic rhinitis and otitis media, with allergens likely playing a role in the development of OME. [15] Bacterial infections and Eustachian tube obstruction (ETO) are the main risk factors.[16] Epidemiologic studies often show allergies as a risk factor for otitis media, with a higher frequency observed in patients with otitis media than predicted. The prevalence of allergies in patients with otitis media ranged from 25% to 89%.[17,18] There is also a conclusive link between middle ear dysfunction and upper respiratory allergies.[19] The link between allergy and otitis media with effusion is thought to be due to cytokines, colony-stimulating factors, and inflammatory mediators secreted by mucosal mast cells, other inflammatory cells, and epithelial cells in the nose and nasopharynx.[20] These mediators causes obstruction of the Eustachian tube, resulting in tympanic membrane retraction and conductive hearing loss.[21]

Numerous studies suggest that the middle ear may play a crucial role in the United Airway Concept and the link between allergies and Middle Ear Emissions (MEE).[22] A study found that individuals with allergic rhinitis experienced more frequent hearing loss and otoacoustic emission disturbances.[23] Nasal allergies can affect the Eustachian tube's function, affecting the pressure in the middle ear and reducing hearing. Nasal challenges with allergens, performed by rhinomanometry, tympanometry, and PTA, can be a helpful diagnostic adjunct for chronic OME. Studies also show a correlation between ETD and a decrease in MEP in otitis media with effusion.[24]

The study aims to investigate otological changes associated with allergic rhinitis, distributing patients based on the ARIA score, assessing the impact of tympanic membrane changes, and studying the correlation between middle ear pressure changes and allergic rhinitis duration.

METHODS

This was a cross-sectional observational study conducted in the Department of ENT at Santosh Medical College and hospital, Ghaziabad over a period of one year. Total 130 patients provided informed consent, keeping data confidential, and obtain clearance from an ethical committee. All patients with nasal obstruction, sneezing, and nasal, ocular itching who were willing to give written informed consent were included. Exclusion criteria included ear diseases, history of prior surgery, Deviated Nasal Surgery, Concha bullosa, Nasal polyposis, use of ototoxic agents, metabolic and systemic diseases causing hearing loss, and otoscopic evidence of perforated tympanic membrane.

Patients with allergic rhinitis were evaluated through history taking, clinical examination, and diagnostic nasal endoscopy. Diagnostic nasal endoscopy was performed for patients with positive anterior rhinoscopy findings or those with deviated nasal septum or hypertrophied inferior turbinate. Tympanometry was performed for all patients, while pure tone audiometry was used for those with reduced hearing or tuning forks test suggestive of impaired hearing. Tools used to measure outcomes included otoscopy, tuning fork test, pure tone audiometry, and tympanogram.

The study used a combination of quantitative and qualitative data management and statistical analysis. Quantitative data was presented using mean and standard deviation, while qualitative data was presented using frequency and percentage tables. Associations were assessed using Fisher tests, student t-tests, and Chi-Square tests. A p-value less than 0.05 was considered significant. Pearson's chi-squared test was used to analyze the data. Results were graphically represented and statistical software, including MS Excel and SPSS version 26, was used for analysis.

RESULTS

The study analyzed the distribution of patients based on age, gender, duration of disease, and severity of allergic rhinitis and its effects on asthma (ARIA). The majority of patients were aged 31-40 years, with 70% falling within this age range. The majority of patients were male (55.38%), with 58 (44.62%) female. The duration of the disease varied, with 26.92%, 28.46%, 22.31%, 6.92%, and 15.38% having a duration of less than a year. The frequency of mild, moderate, and severe ARIA was 63.08%, 20.00%, and 16.92%, respectively. The main complaints were also discussed. (Table 1)

Table 1: Distribution of Patients Categorized by Age, Gender, Disease Duration, and Severity of Allergic Rhinitis and its Impact on Asthma (ARIA), as Well as the Severity of the Disease.

Age group		Number of patients	Percentage (%)
Gender (n=130)	Male	72	55.38%
	Female	58	44.62%
Age (years) n=130	≤20years	19	14.62%
	21-30 years	32	24.62%
	31-40 years	40	30.77%
	41-50 years	18	13.85%
	51-60 years	21	16.15%
Duration of Disease	<1 year	35	26.92
	1-2 years	37	28.46
	3-5 years	29	22.31
	6-10 years	9	6.92
	>10 years	20	15.38
Severity of ARIA	Mild	82	63.08
	Moderate	26	20.00
	Severe	22	16.92

The study found that the percentage of complications in the right ear was 23.85%, while in the left ear it was 16.15%, 27.69%, 3.85%, 1.54%, and 2.31%. The distribution of patients was based on the pars flaccida (PF) grades, with normal, grade 1, and grade 2, Pars Flaccida in the right ear were 97.69%, 0.77%, and 1.54% in the left ear. The percentage of Tympanosclerotic patches in pars tensa (PT) was also high. (Table 2)

Table 2. Distribution of Patients Based on Different Pars Flaccida (PF) Grading and Pars Tensa (PT) Conditions.

		Right Ear		Left Ear	
		n	%	n	%
Chief complaint	Blocking sensation	31	23.85	21	16.15
	Itching	26	20.00	36	27.69
	Popping sound	6	4.62	5	3.85
	HL	5	3.85	2	1.54
	Earache	1	0.77	3	2.31
Otoscopy	Pars flaccida (PF)				
	Normal	126	96.92	127	97.69
	Grade 1	3	2.31	1	0.77
	Grade 2	1	0.77	2	1.54
	Pars tensa (PT)				
	Normal	75	57.69	38	29.23
	Grade 1	20	15.38	12	9.23
	Grade 2	28	21.54	67	51.54
	TS patch	7	5.38	13	10.00

The distribution of patients based on their tympanic membrane (TM) mobility, with 88 patients having TM mobility in the right ear and 71.54% in the left ear. The tuning fork test (TFT) showed a positive distribution of 105 patients, with a total of 105 positive in the right and 92.31% in the left. The percentage of centralized, left lateralized, and right lateralized TFT-W was 75.38% in the right ear and 77.69% in the left ear. The TFT-A equivalent was found in all patients ears. The distribution of patients was also categorized by tympanogram types, with the mean hearing threshold being 10.50±2.15 at 250 Hz frequency, 11.8±3.38 at 500 Hz frequency, 14.05±4.12 at 1 KHz frequency, 16.10±3.44 at 2 KHz frequency, 27.41±6.28 at 4 KHz frequency, 31.56±10.56 at 6 KHz frequency, and 38.46±8.92 at 8 KHz frequency. (Table 3)

Table 3. Patient Distribution Based on Tuning Fork Tests (TFT), Tympanogram Types, and the Mean Hearing Threshold.

		Right		Left	
		n	%	n	%
R	Positive	105	80.77	120	92.31
	Negative	25	19.23	10	7.69
W	centralized	98	75.38	101	77.69
	lateralized to left	6	4.62	21	16.15
	lateralized to right	26	20.00	8	6.15
A	equivalent	130	100.00	130	100.00
Types of tympano-gram	A Type	85	65.38	94	72.31
	Ad Type	15	11.54	11	8.46
	As Type	4	3.08	7	5.38
	B Type	6	4.62	0	0.00
	C Type	20	15.38	18	13.85
PTA findings (Hearing Threshold)	Frequency	mean±SD			
	250 Hz	10.50±2.15			
	500 Hz	11.8±3.38			
	1 K Hz	14.05±4.12			
	2 K Hz	16.10±3.44			
	4 K Hz	27.41±6.28			
	6 K Hz	31.56±10.56			
	8 K Hz	38.46±8.92			

The ARIA classification of allergic rhinitis showed that 67.07% of 82 patients experienced intermittent ear symptoms, with 32.93% being persistent mild, 50% intermittent and 50% persistent moderate to severe, and 31.82% intermittent and 68.18% persistent severe. (Table 4)

Table 4. Distribution of Patients With Ear Complaints Based on Allergic Rhinitis and its Impact on Asthma (ARIA) Classification of Allergic Rhinitis

	Mild (n=82)		Moderate to severe (n=26)		Severe (n=22)	
	n	%	n	%	n	%
Intermittent	55	67.07	13	50.00	7	31.82
Persistent	27	32.93	13	50.00	15	68.18

The study analyzed the correlation between mean middle ear pressure and the ARIA classification for allergic rhinitis. Results showed that mild intermittent rhinitis had lower mean middle ear pressure, while moderate to severe persistent rhinitis had higher mean middle ear pressure. Severe persistent rhinitis had lower mean middle ear pressure in both ears. The duration of allergic rhinitis varied from <1 year

to >10 years, with varying degrees of pressure on the right and left ear. The middle ear pressure decreased significantly with the disease duration in both the right and left ear, indicating a significant impact on the condition. (Table 5; Figure 1)

Table 5. Association Between Middle Ear Pressure and Duration of Allergic Rhinitis.

		Right		Left	
		Mean	±SD	Mean	±SD
Duration of Disease	<1 year	-10.48	22.80	-8.09	12.42
	1-2 years	-22.07	27.68	-19.36	23.38
	3-5 years	-20.27	32.55	-34.05	49.31
	6-10 years	-36.94	41.35	-26.06	29.23
	>10 years	-35.70	32.45	-45.69	32.72

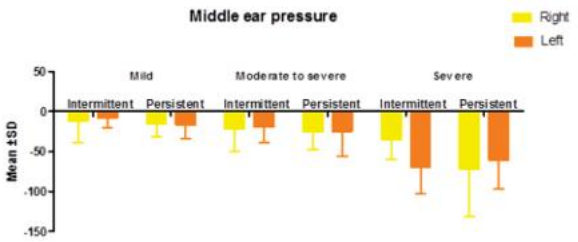

Figure 1. Association Between Average Middle Ear Pressure and ARIA Classification For Allergic Rhinitis.

DISCUSSION

The relationship between nasal allergies and Eustachian tube dysfunction is a widely discussed topic, with studies focusing on the correlation. However, the impact of allergic rhinitis on the middle ear and Eustachian tube function is not fully understood. More research is needed to understand how nasal irritation leads to ear changes and the lasting effects of allergic rhinitis. Additionally, more research is needed to determine the effectiveness of current treatments in ear-related problems.

The study found that the majority of patients with allergic rhinitis (31.77%) were aged 31-40 years, with 70% aged ≤40 years. Deb et al. found that the largest proportion of patients with allergic rhinitis (33.3%) were aged between 30 and 39 years, followed by 30.5% in the 20-29 age group.[25] Mane & Keche's [26] study found that 28.85% of patients were between 10 and 20 years old. Katiyar et al.[27] found that 45% of patients were between 16 and 30 years old. Allergic rhinitis typically manifests at a relatively early stage of life, typically at the age of 19 years. Research indicates that 80% of allergic rhinitis symptoms occur before 20, peaking between 20-40 and declining thereafter. Acute respiratory tract infections are common among children in the first 5 years about 17.2%, with most of them diagnosed between 24-29 months.[28]

The study found that out of 130 patients, 58 (44.62%) were male and 72 (55.38%) were female, with a male-to-female ratio of 1.24. This is consistent with previous studies, of Adegbiji et al.'s [29], Mane et al.[26], Katiyar et al.[27], and Varshney et al.[30]. Both men and women were affected, but men were more frequently affected due to their greater activity and exposure. Pinart et al's comprehensive review and meta-analysis found that the prevalence of rhinitis in infancy is usually higher in males, but this shifts to a higher prevalence in females in adolescence worldwide, except in Asia, where males also have a higher prevalence after childhood.[31]

The study found that allergic rhinitis durations varied from 1-2 years to over 10 years, with a total of 55.38% of patients having a 2-year duration. Katiyar et al[28] reported that 69.4% of patients had rhinitis for more than a year, while 30.6% had a 1-year duration. Bousquet et al [32] found that allergic rhinitis is a chronic condition, with persistent symptoms over several years.

The study found that 82 patients had mild, moderate, and severe allergic rhinitis (ARI), with 67.07% experiencing intermittent symptoms and 32.93% experiencing persistent mild symptoms. The prevalence of allergic rhinitis severity were as follows: mild intermittent rhinitis (25.7%), moderate to severe intermittent rhinitis (16.4%), mild persistent rhinitis (16.4%), and moderate to severe persistent rhinitis (41.2%). Adults are more prone to perennial rhinitis, as reported by Varshney.[30] Bousquet et al[32] found that 10% of patients had mild intermittent allergic rhinitis, 14% had mild persistent allergic rhinitis, 17% had moderate to severe intermittent allergic rhinitis, and 59% had moderate to severe persistent rhinitis. A recent study in China found that the self-reported prevalence of AR varies widely, ranging from less than 10% to over 20%. In Korea, the prevalence of AR has increased from 6% to 10% in the adult population, with severity levels ranging from mild intermittent (25.7%), moderate to severe intermittent (16.4%), mild persistent (16.4%), and moderate to severe persistent (41.2%).[33-35]

The symptoms of allergic rhinitis are often overlooked by the general people and practitioners. However, it is now recognized that allergic rhinitis has a pathological link to its effects on the middle ear, as both have similar inflammation patterns. A study found that the prevalence of congestion (blocking sensation), itching, cracking, hearing loss (HL) and earache in the right ear was 23.85%, 20.00%, 4.62%, 3.85% and 0.77%, respectively. In the left ear, the prevalence of these complications was 16.15%, 27.69%, 3.85%, 1.54% and 2.31%, respectively. The inflammation of the nasal mucosa can spread to the Eustachian tube, disrupting its normal function, leading to insufficient ventilation and drainage of the middle ear.[36] This can result in a feeling of congestion or fullness in the ears, potentially leading to conductive hearing loss.[37] Blockage and dysfunction of the Eustachian tube can impair sound transmission, resulting in a sensation of blocked ears and temporary hearing loss.[38]

The study found that a normal pars flaccida (PF) was prevalent in 96.92% of patients in the right ear , with 2.31% grade 1 and 0.77% grade 2 in the left ear. Retracted PF was only present in moderate to severe allergic rhinitis patients, similar to Katiyar et al's[27] findings that only 1.8% of allergic rhinitis patients had retractions in the ear's pars flaccida.

The study found that the prevalence of normal pars tensa, grade 1, grade 2, and TS patch in the right ear and in the left ear were similar that is 29.23%, 9.23%, 51.54%, and 10.00%. In subjects with allergic rhinitis, the majority had either grade 1 pars tensa retraction or normal tympanic membrane. A small percentage (4%) had grade 3 retractions and 0.9% had grade 4 pars tensa retractions. Allergic rhinitis can cause Eustachian tube dysfunction, negative pressure in the middle ear, and eardrum retraction.[27]

A type "A" tympanogram, indicating normal middle ear pressure and compliance, is frequently reported in individuals with allergic rhinitis, suggesting that the middle ear continues to function well even with nasal inflammation and Eustachian tube dysfunction. The most common type A tympanogram is 65.38%, indicating normal middle ear impedance. The least common type B tympanogram is 3.08%. In total, 26 ears showed deviating tympanograms, particularly type B and type C. Fasunla et al[39] found type A as the most common tympanogram pattern in allergic rhinitis, while type C was the least common. Kim et al [40] found that middle ear function, as assessed by tympanometry, often appears to be normal, despite nasal congestion and Eustachian tube dysfunction.

Allergic rhinitis, a common condition affecting people worldwide, can be categorized into mild, moderate/severe, intermittent, and persistent.[32,41,42] The study found that the average middle ear pressure in patients with mild intermittent rhinitis was -11.09±27.38 and 7.96±12.08

respectively, while in patients with moderate to severe intermittent rhinitis, it was -22.15±27.75 and -19.23±20.06. The severity of allergic rhinitis and its persistent nature can be related to chronic allergic inflammation and Eustachian tube dysfunction. In a study by Knight et al.,[43] the mean middle ear pressure in patients with seasonal allergic rhinitis was recorded as -18 daP. Understanding the pathophysiology and impact of allergic rhinitis on the middle ear can help improve the treatment of these conditions. The study highlights the importance of understanding the ear's pressure and its impact on the patient's quality of life.

The study categorized allergic rhinitis into five groups: less than 1 year, 1-2 years, 3-5 years, 6-10 years, and more than 10 years. The mean values of daP for each group were -10.48±22.80 for less than 1 year, -22.07±27.68 for 1-2 years, -20.27±32.55 for 3-5 years, -36.94±41.35 for 6-10 years, and -35.70±32.45 for more than 10 years. On the left side, the mean values were -8.09±12.42 for less than 1 year, -19.36±23.38 for 1-2 years, -34.05±49.31 for 3-5 years, -26.06±29.23 for 6-10 years, and -45.69±32.72 for more than 10 years. The study found a significant decrease in middle ear pressure with increasing disease duration.[36] However, the study did not explore the influence of the disease duration on middle ear pressure.

The study suggests that clinicians should closely monitor patients with allergic rhinitis for potential otological changes, such as eustachian tube dysfunction and middle ear effusion, to prevent chronic ear conditions and requires further longitudinal studies to understand the long-term impact of allergic rhinitis on otological health.

CONCLUSION

Allergic rhinitis can cause significant otologic abnormalities in the middle ear, including Eustachian tube dysfunction, otitis media, middle ear effusion, tympanic membrane changes, and increased vulnerability to otitis externa. Effective management involves targeting these otologic manifestations to reduce symptoms and prevent potential issues.

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