Association of allergic rhinitis with hypothyroidism, asthma, and chronic sinusitis: clinical and radiological features

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Abstract

Background: Allergic rhinitis (AR) is characterized by mucosal inflammation that leads to a variety of symptoms, such as nasal congestion, rhinorrhea, and sneezing. This rhinitis is triggered by inhalation of allergens, such as pollen, and this condition has a negative impact on the quality of life. AR was shown to be associated with a number of co-morbidities, including hypothyroidism, asthma, and chronic sinusitis.

Objective: This study aimed to assess AR-associated comorbidities in patients presenting symptoms and paranasal sinus computed tomography (CT) scan findings in Taif City, Saudi Arabia.

Methods: This cross-sectional study evaluated medical and radiological records of AR patients retrospectively from the period of December 2018 to September 2019 in Al-Hada Armed Forces Military Hospital, Taif City, Saudi Arabia.

Results: A total of 103 AR patients with a mean age of 39.0 ± 15.6 years with 55.3% males and 44.7% females. The three most common associated comorbidities in allergic rhinitis patients were chronic sinusitis (28.2%), hypothyroidism (21.4%), and asthma (8.7%). Nasal obstruction (30.1%) was the symptom most frequently presented by all patients. Mucosal thickening occurred most frequently in patients with associated chronic sinusitis, while bilateral osteomeatal complex obliteration was observed mostly in asthmatic patients, and bony boundary thinning was more prevalent among patients with associated hypothyroidism.

Conclusion: The gender distribution of AR was 10% more common among males; however, the most common three comorbidities in allergic rhinitis patients were chronic sinusitis, hypothyroidism, and asthma, and most of those patients were females. Hypothyroidism can be a hidden predisposing factor for AR, while chronic sinusitis can be caused by AR due to secretion stasis or immune system activation.

Keywords

Allergic Rhinitis, Asthma, Chronic Sinusitis, CT scan, Hypothyroidism, Nasal obstruction, Paranasal sinuses
INTRODUCTION

Allergic rhinitis (AR) is characterized by nasal congestion that is associated with rhinorrhea, sneezing, nasal and ocular itching, redness, and tearing due to mucosal inflammation. AR can be triggered by inhalation of allergens, such as pollen, dust mites, insects, animal dander, or molds. The level of urbanization and geographical region contribute to the patterns of dominant allergen-related effects. During the first year of life, indoor allergen sensitization occurs before sensitization to pollen, and it is difficult to diagnose AR, especially during the first three years since viral respiratory infections commonly occur in those years and produce symptoms that resemble AR. AR is frequently reported among adults, and it peaks during the second to fourth life decades and then gradually diminishes thereafter. AR has a negative impact on the quality of life and causes missed or unproductive time at work or school along with sleep problems in addition to negatively impacting cognitive function, decision-making ability, and self-perception. The severity of AR symptoms depends on the degree of exposure to the causative agent. The incidence of AR worldwide is estimated to be approximately 600 million people of which 200 million have been reported to suffer concomitant bronchial asthma. Many reports indicate the increasing frequency of sensitization to inhaled allergens worldwide with 40% of the populations in the United States and Europe. Epidemiological studies in Saudi Arabia have proven an increase in the prevalence of AR. A more recent study with participants from different regions in the kingdom found that 34% of Saudis reported to be positive for AR. Case distribution of AR among children in different cities in Saudi Arabia showed that Al-Ahssa has the highest prevalence (48.2%) followed by Riyadh (29%) and Jeddah (24.3%). In cases of mild intermittent AR disease, second generation non-sedating antihistamines are prescribed, but if the patient complains of persistent symptoms that affect the quality of life, the initial treatment of choice consists of intranasal corticosteroids. Meanwhile, patients with more severe disease who do not respond to intranasal corticosteroids with or without second-line therapies should be referred for consideration due to the wide range of allergic triggers and various complications that AR patients have. We aimed to cover some of the lack of literature studies that explore AR radiological and medical profiles, including socio-demographics, associated co-morbidities, symptom presentation, and findings of paranasal sinus computed tomography (CT) scans in Taif City, Saudi Arabia.

MATERIAL AND METHODS

Patient selection

AR patients’ medical records from December 2018 to September 2019 in Al-Hada Armed Forces Military Hospital, Taif City, Saudi Arabia were reviewed retrospectively. Only those who had undergone CT scans of paranasal sinuses as clinically indicated were included. AR patients of all ages who had a fully documented medical record and a CT scan of the paranasal sinuses during the study period were included. Patients were excluded if the CT scan of the paranasal sinuses was ordered for post-operative evaluation.

Data collection

Socio-demographic characteristics of patients, including age and gender, were recorded in addition to their presenting symptoms, any associated acute and chronic comorbidities, findings of clinical examinations, and CT paranasal sinus reports. Approval from the Research Ethics Committee at Al-Hada Armed Forces Hospital was obtained.

Statistical analysis

The Statistical Package for Social Sciences (SPSS) version 25 was used for data analysis. Frequency and percentage were used to express qualitative data, while mean and standard deviation (SD) were used to evaluate quantitative data variables. Significant differences among variables were identified using an independent sample t-test, and a P value ≤ 0.05 was considered significant.

RESULTS

A total sample of 103 allergic rhinitis patients with a mean age of 39.0 ± 15.6 years with 55.3% males and 44.7% females were included in the study. The most common presenting symptoms were nasal obstruction (30.1%), headache (12.6%), and rhinorrhea (11.7%). Clinical examination showed that most patients had a deviated nasal septum (35.9%), hypertrophy of the nasal turbinate (30.1%), and nasal polyps (18.4%). Table 1 shows age, gender, clinical findings, associated comorbidities, and presenting symptoms of AR patients.

Maxillary mucosal thickening was the most common finding among AR patients (43.7%) followed by ethmoidal sinus mucosal thickening (31.1%). Most sinus opacification was observed in the maxillary and ethmoidal sinuses (12.6%). Only 5.8% of the patients had bony boundary thinning, while 10.7% of the patients had middle turbinate pneumatization. Table 2 shows CT paranasal sinus findings from AR patients.

The three most common associated comorbidities in allergic rhinitis patients were chronic sinusitis (28.2%), hypothyroidism (21.4%), and asthma (8.7%), all of them were more predominant in females. Figure 1 shows a Venn diagram of the most common associated comorbidities among our AR patients.

Nasal obstruction was the most frequently presenting symptom in patients with comorbid asthma (44.4%), hypothyroidism (36.4%), and chronic sinusitis (31%) followed by nasal itching in patients with hypothyroidism (P = 0.108), headache in asthmatics (P = 0.369), and...
chonic sinusitis ($P = 0.071$) patients. Tinnitus presented mostly in patients with an associated chronic sinusitis ($P = 0.001$). During clinical examination of patients who had comorbid hypothyroidism and chronic sinusitis, the most common finding was a deviated nasal septum ($P < 0.001$), while patients with nasal polyps more predominantly had asthma ($P < 0.001$). Table 3 shows the age, gender, clinical findings, presenting symptoms in patients with comorbid hypothyroidism, asthma, and/or chronic sinusitis.

Table 4 shows the paranasal sinus CT scans in AR patients with comorbid hypothyroidism, asthma, and/or chronic sinusitis. CT scans of the paranasal sinus showed that mucosal thickening in the maxillary ($P < 0.001$), sphenoidal ($P = 0.027$), frontal ($P = 0.246$) and ethmoidal ($P = 0.003$) sinuses were the most common in patients with associated chronic sinusitis, while those who had a bilateral osteomeatal complex obliteration were mostly asthmatic patients ($P = 0.069$). Bony boundary thinning was more prevalent among patients with associated hypothyroidism ($P = 0.79$). Figure 2 shows a comparison of paranasal sinus CT findings among AR patients who had comorbid hypothyroidism, chronic sinusitis, and/or asthma and those who did not have those conditions.

### DISCUSSION

AR has a negative impact on the quality of life and productivity, and it can be an economic burden. Thus, studying the exact presenting symptoms, clinical profiles, and radiological findings of those patients is a necessity, especially when the literature concerning the Taif region is lacking. In developed countries, AR is considered to be one of the most frequently occurring atopic diseases with a prevalence of 40% in children, and 30% in adults. The severity of AR is affected by the degree of allergen exposure and the level of air pollution. The sample of AR patients in the current study was obtained from a central hospital in Taif region, which is well-known for the presence of many types of fruit farming that spread many pollen grains throughout the year. This finding may shed some light on the main causative allergen of AR in the studied region. One study that was conducted in Riyadh City found a strong relationship between pollen grain spread and AR development. Moreover, of the main causes of AR, air pollution comes between the important elements. Dust particles and different microorganisms can be carried by sandstorms, and they can stimulate or exaggerate AR. Indeed, Taif Region is well-known for the presence of many mountains and
desert areas over which allergens and dust can spread since the country is exposed to many sandy storms all over the year. Therefore, this studied region is considered to be exposed to multifactorial inducers of AR.

In 1936 Chavanne first noticed that patients who underwent thyroidectomy had a subsequent nasal turbinates engorgement that can be cured by thyroxin injections. In 1960 Weisskopf performed the first histopathological examination of the nasal mucosa in patients with hypothyroidism, he reported an increase in the ground matter of connective tissue and hypertrophy in the mucous glands. More recent experimental studies to investigate the association between hypothyroidism and rhinitis have been done on rats in which

**Table 2**

| Variables                  | Number | Percentage (%) |
|----------------------------|--------|----------------|
| Mucosal thickening         |        |                |
| Nasal                      | 8      | 7.8            |
| Maxillary                  | 45     | 43.7           |
| Sphenoidal                 | 22     | 21.4           |
| Frontal                    | 17     | 16.5           |
| Ethmoidal                  | 32     | 31.1           |
| All sinuses                | 8      | 7.8            |

| Sinus opacification        |        |                |
| Maxillary                  | 13     | 12.6           |
| Sphenoidal                 | 12     | 11.7           |
| Frontal                    | 12     | 11.7           |
| Ethmoidal                  | 13     | 12.6           |

| Osteomeatal complex obliteration |        |                |
| Unilateral                  | 7      | 6.8            |
| Bilateral                   | 11     | 10.7           |

| Maxillary retention cyst    |        |                |
| Unilateral                 | 3      | 2.9            |
| Bilateral                  | 2      | 1.9            |

| Bony spur                  | 4      | 3.9            |
| Sphenoidal recess opacification | 1 | 1.0 |
| Cribriform plate defect     | 1      | 1.0            |
| Sinus air fluid level       | 2      | 1.9            |
| Bony boundaries thinning    | 6      | 5.8            |
| Middle turbinate pneumatization | 11 | 10.7 |

**Figure 1** Venn diagram of associated comorbidities among allergic rhinitis patients

**Table 3**

| Variables                  | Associated comorbidities | Chronic sinusitis |
|----------------------------|--------------------------|-------------------|
| Frequency (n)              | Hypothyroidism | Asthma | Chronic sinusitis |
| 22                         | 22 (21.4%)    | 9 (9.1%) | 29 (28.2%)   |
| Age (years, mean ± SD)     | 41.0 ± 11.2  | 44.3 ± 15.6 | 39.5 ± 14.0 |
| Gender (n, %)              | Females | 20 (35.1%) | 6 (10.5%) | 17 (29.8%) |
| Males                      | 2 (4.3%)    | 3 (6.5%)  | 12 (26.1%) |

| Presenting symptoms (n, %) |
| Rhinorrhea | 3 (10.3%) |
| Nasal itching | 2 (6.9%) |
| Sneezing | 2 (6.9%) |
| Headache | 2 (24.1%) |
| Nasal obstruction | 9 (31.0%) |
| Facial pain | 3 (10.3%) |
| Hearing loss | 3 (10.3%) |
| Otalgia | 1 (3.4%) |
| Tinnitus | 4 (13.8%) |
| Sleep apnoea | 1 (3.4%) |
| Ansomnia | 4 (13.8%) |
| Snoring | 4 (13.8%) |

| Findings on clinical examination (n, %) |
| Acquired deformity of the nose | 1 (11.1%) |
| Deviated nasal septum | 10 (34.5%) |
| Hypertrophy of nasal turbinate | 6 (20.7%) |
| Nasal polyp | 7 (24.1%) |
| Hypertrophied of adenoid | 2 (6.9%) |

In 1936 Chavanne first noticed that patients who underwent thyroidectomy had a subsequent nasal turbinates engorgement that can be cured by thyroxin injections. In 1960 Weisskopf performed the first histopathological examination of the nasal mucosa in patients with hypothyroidism, he reported an increase in the ground matter of connective tissue and hypertrophy in the mucous glands.
acid mucopolysaccharide production was increased in the nasal and paranasal sinus regions leading to rhinitis in rats with experimentally induced hypothyroidism. Additionally, thyroid hormone receptors are localized in the nasal mucosa and a reported link with hypothyroidism between rats’ nasal mucosal inflammation and edema was found. Hormonal rhinitis caused by hypothyroidism is now accepted as one of the causes of non-allergic rhinitis. The percentage of patients with hypothyroidism who experience rhinitis symptoms is estimated to be around 3%. Hypothyroidism can be a hidden predisposing factor for rhinitis, and the only treatment of non-responsive rhinosinusitis in the presence of a comorbid hypothyroidism is its correction. Data of hypothyroidism prevalence among the general Saudi Population is still not available, however, a single center study in Saudi Arabia estimated the prevalence of subclinical hypothyroidism to be around 10%. In the current study, 21.4% of our Allergic Rhinitis patients had subclinical hypothyroidism and they were mostly females. A study shows that the incidence of subclinical hypothyroidism is 4-fold that of males. This finding may suggest that hypothyroidism might be a predisposing factor for rhinitis, especially in females.

The association between AR and asthma may be attributed to the same allergen that induces AR. The coexistence of allergic diseases including, asthma, dermatitis and rhinitis are common to occur in the same patient. Additionally, in genome-wide association studies, risk variants were shown to be shared between asthma, dermatitis, and rhinitis. The proposed mechanism of the association between AR and asthma has been recently augmented by the identification of a signature of eight genes responsible for the concurrent development of asthma, rhinitis, and dermatitis. The prevalence of Asthma among Allergic Rhinitis patients is estimated to be around 40%. However, in the current study only 8.7% of our sample of Allergic Rhinitis patients had asthma, local studies showed that asthma prevalence in Taif Region is 6.4%.

28.2% of AR patients in the current study had chronic sinusitis, making chronic sinusitis the most common associated comorbidity in our sample of patients. Allergic rhinitis may play a role in the development of more than 30% of chronic sinusitis cases. One study that investigated the paranasal sinuses CT scans found that perennial AR was associated with sinusitis in 67.5% of patients compared to only 33.4% in those without perennial AR. Moreover, CT scans showing sinus involvement in allergic patients is double that of those non-allergic. The inflammation of the nasal mucosa during the course of AR and the associated damage to the ciliary apparatus may cause obstruction of the drainage from the sinuses through the ostial passage with consequent secretion stasis and resultant sinusitis development.

The association between chronic sinusitis and AR could be also attributed to the immune activation of lymphocytes and basophils in response to allergens, suggesting atopy as a risk factor for the initiation and exacerbation of both conditions. Indeed, a strong association between AR and chronic sinusitis in our sample of Allergic Rhinitis patients was mainly found in allergic patients is double that of those non-allergic. The prevalence of subclinical hypothyroidism among Allergic Rhinitis patients is estimated to be around 10%. The use of CT scanning to detect and identify paranasal sinuses mucosal lining abnormalities has been validated three decades ago. The use of CT scanning to detect and identify paranasal sinuses mucosal lining abnormalities has been validated three decades ago. Mucosal thickening in the maxillary, sphenoidal, frontal, and ethmoidal sinuses was mainly found in patients with chronic sinusitis, which could be attributed to predisposing AR-associated chronic sinusitis in our sample of patients. In agreement with this hypothesis, the presence of maxillary mucosal thickening is thought to increase the probability of an allergic-induced chronic sinusitis.

Some of the limitations in the current study include that it was a single-center study with a retrospective data analysis. Additionally, this study excluded all Allergic Rhinitis patients who did not perform a CT scan of the paranasal sinuses.

### Table 4: Computerized topography paranasal sinuses findings in allergic rhinitis patients with an associated hypothyroidism, asthma, and chronic sinusitis

| Variables | Associated comorbidities | Hypothyroidism | Asthma | Chronic sinusitis |
|-----------|--------------------------|----------------|--------|-------------------|
| CT findings (n, [%]) | | | | |
| | | | | |
| Nasal | 1 (4.5) | 1 (11.1) | 1 (3.4) |
| Maxillary | 13 (59.1) | 6 (66.7) | 22 (75.9) |
| Sphenoidal | 7 (31.8) | 5 (55.6) | 11 (37.9) |
| Frontal | 4 (18.2) | 4 (44.4) | 7 (24.1) |
| Ethmoidal | 11 (50.0) | 6 (66.7) | 16 (55.2) |
| Sinus opacification | | | | |
| Maxillary | 2 (9.1) | 3 (33.3) | 2 (6.9) |
| Sphenoidal | 2 (9.1) | 3 (33.3) | 2 (6.9) |
| Frontal | 3 (13.6) | 4 (44.4) | 3 (10.3) |
| Ethmoidal | 2 (9.1) | 3 (33.3) | 2 (6.9) |
| Osteomeatal complex obliteration | | | | |
| Unilateral | 3 (13.6) | 1 (11.1) | 3 (10.3) |
| Bilateral | 1 (4.5) | 4 (44.4) | 310.3 |
| Maxillary retention cyst | | | | |
| Unilateral | 1 (4.5) | 0 | 0 |
| Bony spur | 2 (9.1) | 0 | 2 (6.9) |
| Sphenoidal recess opacification | 0 | 0 | 1 (3.4) |
| Sinus air fluid level | 1 (4.5) | 0 | 2 (6.9) |
| Bony boundaries thinning | 3 (13.6) | 2 (22.2) | 1 (3.4) |
| Middle turbinate pneumatization | 2 (9.1) | 0 | 2 (6.9) |
CONCLUSION

Taif region is considered to be exposed to multifactorial inducers of AR. The gender distribution of AR was 10% more common among males; however, the three most common comorbidities in AR patients were chronic sinusitis, hypothyroidism, and asthma, and most of those patients were females. Hypothyroidism can be a hidden predisposing factor of rhinitis, especially in females. AR and asthma may be attributed to the same allergen, while chronic sinusitis can be caused by AR due to secretion stasis or immune system activation.

AUTHOR CONTRIBUTIONS

Sara Ahmad Assiri: Conceptualization, Methodology, Software. Raad M. M. Althaqafi: Data curation, Writing- Original draft preparation. Atheer Alsufyani: Visualization, Investigation. Aljuaid Eidha Fawzan: Supervision, Validation. Ahmad Saeed A. Alghamdi: Writing-Reviewing and Editing.

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CONFLICT OF INTEREST

None.

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