# Original Article

# Abnormalities on computed tomography scans of the paranasal sinus in adult patients with allergic rhinitis*

EDUARDO VIEIRA PONTE[1], FABIANA LIMA[2], GLAUBER FERRAZ AGUIAR[3], FABÍOLA GOYANA[4], MARCELO BENÍCIO DOS SANTOS[5], ÁLVARO AUGUSTO CRUZ[6]

## ABSTRACT

**Objective:** To evaluate, using computerized tomography, the frequency of paranasal sinus involvement in patients with allergic rhinitis. **Methods:** From among outpatients diagnosed with rhinitis and complaining of nasal obstruction, 60 were selected for evaluation. The patients were submitted to anterior rhinoscopy, skin prick test for reactivity to aeroallergens and computed tomography of the paranasal sinuses. In addition, questionnaires designed to evaluate symptom severity were administered. The Lund score was used to evaluate paranasal sinus involvement on computed tomography scans. **Results:** Computed tomography scans of the paranasal sinuses were abnormal in 31 patients (52%). The sum of the largest diameters of cutaneous reactions to the aeroallergens, symptom severity and anterior rhinoscopy findings did not differ between patients with paranasal sinus involvement and those without. All the patients with paranasal sinus abnormalities also presented ostiomeatal complex abnormalities, whereas only 11 patients (38%) without paranasal sinus involvement presented such abnormalities ($p < 0.01$). **Conclusion:** In a sample of patients with allergic rhinitis, the frequency of paranasal sinus abnormalities on computed tomography scans was elevated and did not correlate with symptom severity or skin prick test reactivity but was correlated with osteomeatal complex obstruction.

**Keywords:** Rhinitis; Sinusitis; Tomography, X-ray computed; Paranasal sinuses/radiography

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*Study carried out at the Respiratory Diseases Center of the Hospital Universitário Professor Edgard Santos (Professor Edgard Santos University Hospital) of the Faculdade de Medicina da Universidade Federal da Bahia (UFBA, Federal University of Bahia School of Medicine), Salvador, Bahia, Brazil

1. Masters student in Medicine and Health at the Hospital Universitário Professor Edgard Santos (Professor Edgard Santos University Hospital) of the Faculdade de Medicina da Universidade Federal da Bahia (UFBA, Federal University of Bahia School of Medicine), Salvador, Bahia, Brazil
2. Researcher at the Respiratory Diseases Center of the Faculdade de Medicina da Universidade Federal da Bahia (UFBA, Federal University of Bahia School of Medicine), Salvador, Bahia, Brazil
3. Resident physician at the Department of Otorhynolaryngology of the Hospital Universitário Professor Edgard Santos (Professor Edgard Santos University Hospital) of the Faculdade de Medicina da Universidade Federal da Bahia (UFBA, Federal University of Bahia School of Medicine), Salvador, Bahia, Brazil
4. Physician in the Radiology Department of the Hospital Universitário Professor Edgard Santos (Professor Edgard Santos University Hospital) of the Faculdade de Medicina da Universidade Federal da Bahia (UFBA, Federal University of Bahia School of Medicine), Salvador, Bahia, Brazil
5. Full Professor of Radiology at the Faculdade de Medicina da Universidade Federal da Bahia (UFBA, Federal University of Bahia School of Medicine), Salvador, Bahia, Brazil
6. General Coordinator of the Respiratory Diseases Center of the Faculdade de Medicina da Universidade Federal da Bahia (UFBA, Federal University of Bahia School of Medicine), Salvador, Bahia, Brazil

Correspondence to: Eduardo Ponte. Rua Augusto Vianna s/n, 3o andar, Salvador - BA. CEP: 40110-160.
Tel.: 55 71 3203-2749; 3339-6285. E-mail: evponte@yahoo.com.br
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## INTRODUCTION

Rhinitis is an inflammatory process that affects the mucosa of the nasal membrane and whose clinical characteristics include a history of congestion, rhinorrhea, sneezing, nasal itchiness and, occasionally, hyposmia.[1] Rhinitis and sinusitis are frequently seen as distinct diseases, the former typically having an allergic etiology when the symptoms are recurrent, and the latter having an infectious etiology. However, this paradigm may not be completely correct. There is evidence that the inflammatory process in the paranasal sinuses may have an allergic etiology.[2-4]

It has been consistently demonstrated that there is an interrelationship between the upper and lower airways in asthma and allergic rhinitis. Analysis of a random sample of patients who participated in the European Community Respiratory Health Survey demonstrated that asthma was strongly correlated with rhinitis, even in nonatopic patients.[5] The existence of a bidirectional relationship in the inflammatory process of the lower and upper airways has also been investigated. Bronchial challenge with allergen causes an inflammatory process not only in the bronchi but also in the nasal mucosa.[7] These findings have led some authors to consider rhinitis, sinusitis and asthma as possible manifestations of the same disease, characterized as allergic airway disease.

The nasal mucosa and the paranasal sinus mucosa are one and the same since there are no barriers between these two compartments. Considering the concept of allergic airway disease, it would be expected that a large percentage of patients with allergic rhinitis would present inflammation of the paranasal sinuses. The primary objective of the present study was to use computed tomography to determine the frequency of radiological abnormalities compatible with paranasal sinus inflammation in patients with allergic rhinitis. The secondary objectives were to look for correlations between abnormalities on computed tomography scans of the paranasal sinuses and the severity of rhinitis symptoms and to use anterior rhinoscopy to evaluate the abnormalities described and the severity of cutaneous reactions to allergens.

## METHODS

We selected consecutive patients treated at the Pulmonology clinic of the Hospital Universitário Professor Edgard Santos (Professor Edgard Santos University Hospital) of the Universidade Federal da Bahia (Federal University of Bahia). All patients were twelve years of age or older, had been diagnosed with rhinitis, complained of nasal obstruction and presented positive reactions to at least one of the aeroallergens tested via skin prick test.

We excluded patients presenting clinical evidence of airway infection, as well as patients with pronounced deviated septum, nasal polyps and other nasal diseases that are identifiable through the use of anterior rhinoscopy. In addition, patients diagnosed with moderate or severe asthma and patients with severe comorbidities were excluded, as were patients who were being treated with antibiotics, nasal vasoconstrictors, antihistamines, or topic or systemic corticosteroids. Pregnant women (positive for serum beta-human chorionic gonadotropin) were also excluded.

The study was approved by the Ethics in Research Committee of the institution, and all patients gave written informed consent.

In this cross-sectional study, patients were submitted to clinical examination, anterior rhinoscopy, administration of a symptom severity scale questionnaire and skin prick tests for reactivity to aeroallergens, as well as to computed tomography scan of the paranasal sinuses. This entire process was completed within 48 hours at most.

After the clinical examination, patients completed a visual analog scale questionnaire related to symptom severity. Using this scale, each patient designated the severity of the rhinitis symptoms on a horizontal line ranging from 0 to 100 mm, from left to right. Absence of symptoms was defined as 0 mm and the greatest symptom intensity as 100 mm. Patients also classified symptoms as absent, mild, moderate or severe. The symptoms evaluated were nasal obstruction, rhinorrhea, nasal itchiness, sneezing, and watery eyes. Patients who indicated less than 50 mm on the visual analogue scale were excluded.

The nasal fossae were examined by anterior rhinoscopy. The parameters were classified as normal or altered based on the color of the mucosa. Mucosal

edema, turbinate hypertrophy, pathologically characteristic secretion, nasal obstruction, rhinorrhea, deviated septum and polyps were noted as present or absent.

Skin prick tests for reactivity to aeroallergens were carried out on the forearm, using the puncture technique. The antigens used were Dermatophagoides pteronyssinus, Dermatophagoides farinae, Blomia tropicalis, Alternaria alternata, Cladosporium herbarum, Aspergillus fumigatus and Paspalum notatum, as well as dog and cat dander (IPI ASAC Brasil®, São Paulo, Brazil). A positive control (histamine) and a negative control (saline solution) were adopted. The size of the papule was measured fifteen minutes after the antigen had been introduced, and the test was considered positive when the largest diameter measured was at least 3 mm greater than that of the negative control. The sum of the largest diameters of the cutaneous reactions was used to evaluate the degree of cutaneous reactivity to aeroallergens.

Patients were submitted to computed tomography scans of the paranasal sinuses, with axial and coronal slices of 2 mm and 5 mm along the face. A radiologist who was blinded as to the clinical profiles of the patients analyzed the images and classified them according to the Lund score for staging the involvement of the paranasal sinus mucosa. The score for each paranasal sinus is 0 if it presents no abnormalities, 1 if it presents partial opacity and 2 if it presents total opacity. The score for the ostiomeatal complex is 0 if it is not obstructed and 2 if it is obstructed. The total score may range from 0 to 24. Although the following anatomic variants were registered, they did not contribute to the total score: absence of frontal sinus, presence of concha bullosa, paradoxical middle turbinate, bulging uncinate process, Haller's cell, agger nasi cell and deviated septum. The Lund score was chosen because it presents greater reproducibility than do other tests described in the literature.[9] Patients were divided into two groups: with paranasal sinus involvement (total score = 6) and without paranasal sinus involvement (score < 6).[10]

Statistical analysis was carried out using the SPSS software program for Windows. Continuous variables were described as medians and interquartile ranges. In addition to the descriptive analysis, we carried out a comparative analysis of the patients, who were grouped according to the presence or absence of paranasal involvement on the computed tomography scans. The chi-square test, together with either Fisher's exact test or Mann-Whitney test (whichever was applicable), was used. Values of $p < 0.05$ were considered statistically significant, and all tests were two-tailed.

## RESULTS

The study sample included 60 patients. Median age was 29 years (range, 22-39 years) and 24 (40%) were male. Nasal obstruction occurred in 100% of patients, sneezing in 95%, nasal itchiness in 92%, rhinorrhea in 89%, and watery eyes in 87%. At least one of the symptoms was classified as severe in 47% of patients, whereas at least one was classified as moderate in 53%. All patients presented some abnormality on the anterior rhinoscopy.

**TABLE 1**

**Characteristics of patients with abnormalities on computed tomography scans of the paranasal sinuses and of those without such abnormalities**

| | Lund Score ≥ 6 (n = 31) | Lund Score < 6 (n = 29) | p |
|---|---|---|---|
| Gender | | | |
| Male n (%) | 11(36) | 13 (45) | 0,46 |
| Female n (%) | 20 (64) | 16 (55) | |
| Age | 27 (21 - 40) | 30 (25 - 36) | 0,5 |
| Sum of the largest diameters of cutaneous reactions | 20 (16 - 24) | 19 (14 - 25) | 0,49 |
| Nasal obstruction (%) | 31 (100) | 29 (100) | |
| Sneezing (%) | 30 (93) | 27 (97) | 0,60 |
| Nasal itchiness (%) | 27 (87) | 28 (97) | 0,35 |
| Rhinorrhea (%) | 26 (84) | 27 (93) | 0,42 |
| Watery eyes (%) | 27 (87) | 25 (86) | 1,00 |

TABLE 2

**Symptom severity (analogue visual scale) in patients with abnormalities on computed tomography scans of the paranasal sinuses and in those without such abnormalities**

| | Lund Score ≥ 6 (n = 31) | Lund Score < 6 (n = 29) | p |
|---|---|---|---|
| Nasal obstruction (mm) | 73 (65 - 85) | 75 (64 - 80) | 0,61 |
| Sneezing (mm) | 62 (21 - 84) | 67 (22 - 89) | 0,63 |
| Nasal itchiness (mm) | 63 (24 - 82) | 70 (23 - 81) | 0,85 |
| Rhinorrhea (mm) | 45 (21 - 82) | 31 (9 - 64) | 0,09 |
| Watery eyes (mm) | 38 (16 - 62) | 19 (3 - 47) | 0,10 |

TABLE 3

**Frequency of paranasal sinus involvement, according to the Lund criteria, in patients with abnormalities on computed tomography scans and in those without such abnormalities**

| | Lund Score ≥ 6 (n = 31) | Lund Score < 6 (n = 29) | p |
|---|---|---|---|
| Radiological abnormality of the ostiomeatal complex n (%) | 31 (100) | 11 (38) | < 0,01 |
| Deviated septum n (%) | 6 (19) | 4 (14) | 0,56 |
| Radiological abnormality of the sphenoid sinus n (%) | 8 (26) | 2 (7) | 0,05 |
| Radiological abnormality of the frontal sinus n (%) | 12 (39) | 1 (4) | < 0,01 |
| Radiological abnormality of the ethmoid cells n (%) | 29 (94) | 10 (35) | < 0,01 |
| Radiological abnormality of the maxillary sinuses n (%) | 31 (100) | 13 (45) | < 0,01 |

Skin prick tests were positive for D. pteronyssinus in 53 patients (88%), for D. farinae in 44 (73%), for B. tropicalis in 45 (75%), for A. alternata in 38 (63%), for C. herbarum in 24 (40%), for P. notatum in 23 (38%), for A. fumigatus in 22 (37%), for cat dander in 18 (30%) and for dog dander in 9 (15%). The median sum of the largest diameters of the cutaneous reactions in skin prick tests was 20 mm (range, 15-25 mm).

Paranasal sinus abnormalities on computed tomography scans (Lund score > 6) were seen in 31 patients (52%). Table 1 shows that age, gender and sum of the largest diameters of cutaneous reactions of patients with a Lund score = 6 were similar to those of patients with a score < 6. There was no difference between the groups regarding the severity of the symptoms evaluated using the visual analogue scale (Table 2).

Of those patients with abnormalities on computed tomography scans, 100% presented maxillary sinus abnormalities, 94% presented ethmoidal cell abnormalities, 39% presented frontal sinus abnormalities, and 26% presented sphenoid sinus abnormalities. It was observed that all patients with a score > 6 presented ostiomeatal complex abnormalities on computed tomography scans, whereas only 11 patients (38%) with a score < 6 presented this kind of abnormality (p < 0.01) (Table 3). None of the patients presented an air-fluid level in the paranasal sinuses.

The frequency of each of the abnormalities observed by anterior rhinoscopy, as well as the frequency of the anatomic variants, was similar between patients with paranasal sinus abnormalities and those without.

## DISCUSSION

We found a high frequency of paranasal sinus abnormalities on the computed tomography scans of patients who presented allergic rhinitis with no clinical evidence of airway infection. This finding reinforced the hypothesis that there is a strong correlation between allergic rhinitis and sinusitis. Some authors compared paranasal sinus computed tomography findings of patients diagnosed with allergic rhinitis with those of patients presenting no upper airway diseases and found a correlation between rhinitis and sinusitis.[11] However, the mechanism responsible for this correlation has yet to be elucidated. There is a possibility that the inflammatory process of the nasal mucosa would propitiate accumulation of secretion in the paranasal

sinuses since it blocks their drainage via the ostia, thereby facilitating the onset of an infectious process. This would be an unlikely explication for our finding since there were no clinical manifestations of infection in the patients we evaluated. Another possibility, which we consider the most plausible, is that the inflammatory process of the paranasal mucosa has an allergic etiology.

Some findings corroborate the allergic etiology for many cases of paranasal sinus inflammation. Studies of patients with chronic sinusitis have demonstrated that the intensity of paranasal sinus involvement correlates with eosinophilia in peripheral blood, total IgE serum levels, specific IgE serum levels and frequency of diagnosis of asthma.[12-15] Some authors, while studying patients with allergic rhinitis, have demonstrated that nasal challenge with allergens can cause symptoms and radiological abnormalities that are consistent with sinusitis.[2] Others have used nasal challenge with antigens to induce influx of eosinophils into the sinuses of allergic volunteers.[16] Biopsy studies of paranasal sinus mucosa have demonstrated that the most prominent histological characteristic in patients with chronic sinusitis is eosinophil infiltrate. When analyzed separately, patients with chronic sinusitis and presenting positivity on the skin prick test for aeroallergens have a greater number of intraepithelial mastocytes and increased interleukin-5 production than do patients with chronic sinusitis who do not present positivity on the skin prick test.[3-4]

In the present study, upper airway symptom severity was similar between patients with paranasal sinus involvement and those without. Other studies of patients with chronic sinusitis have obtained similar results.[17-18] Some authors have demonstrated that clinical treatment of patients with seasonal allergic rhinitis effects improvement in airway symptoms, although paranasal sinus involvement seen on computed tomography scans may remain unchanged.[19] These findings have practical implications. Since the objective of the treatment for allergic rhinitis is to control the symptoms, computed tomography, which would be an indicator of sinus involvement severity, is not relevant to the choice of clinical treatment or the evaluation of the response to treatment. Similarly, taking into account the fact that most asthmatics have concomitant rhinitis, the practice of using computed tomography scans of the paranasal sinus to identify individuals with asthma who are likely to present subclinical infectious sinusitis probably, in most cases, results in unnecessary antibiotic therapy. Due to the absence of clinical symptoms and signs, it is not possible to completely rule out the possibility of infectious sinusitis. However, a correlation between the intensity of the sinus involvement and eosinophilia in peripheral blood and in nasal secretions has been described, reinforcing the hypothesis of predominant allergic inflammation.[20] A comparable finding was described in a study conducted in 2002, in which induced sputum and peripheral blood of patients with severe asthma and abnormalities on computed tomography scans of the paranasal sinuses were analyzed.[21]

The correlation between ostiomeatal complex obstruction and sinusitis observed in the present study had previously been identified by other authors and reinforces its importance in the sinusitis physiopathology.[12,22] It is possible that concomitant ostiomeatal complex involvement and allergic inflammation of the mucosa with edema and hypersecretion may contribute to the onset of obstructive phenomena in the paranasal sinus drainage routes. This would lead to accumulation of secretion in the paranasal sinus cavities and a consequent higher frequency of abnormalities on computed tomography scans. Anatomic variants were not found to be relevant in this process. The lack of a correlation between computed tomography findings and abnormalities seen by anterior rhinoscopy may be due to the high percentage of patients with rhinoscopic abnormalities.

We can conclude that the frequency of abnormalities on computed tomography scans of the paranasal sinuses in this sample of adults with allergic rhinitis was high and was not correlated with symptom severity or cutaneous reaction to allergens but only with ostiomeatal complex obstruction.

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