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Evaluation of airway hyperresponsiveness in chronic rhinosinusitis: values of sinus computed tomography

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ABSTRACT

Background: Chronic rhinosinusitis (CRS) is tightly linked to airway hyperresponsiveness (AHR) and asthma. However, the practical surrogate parameters for evaluating AHR in patients with CRS remain unclear.
Objectives: To evaluate the diagnostic values of sinus computed tomography for AHR in patients with CRS.
Methods: We performed a prospective, single-blinded study of 125 consecutive patients with CRS. These patients were subdivided into AHR and non-AHR (NAHR) groups based on histamine provocation test results. The following parameters were compared between 2 groups of CRS patients: Lund-Mackay scores, olfactory cleft (OC) scores, and serum eosinophil counts.
Results: Fifty-seven patients (45.4%) presented with AHR. The OC scores, the ratio of OC scores to total scores, and the eosinophil counts in the AHR group were significantly higher than those in the NAHR group ($P < .001$). Multivariate logistic regression revealed that OC scores and eosinophil counts were independent risk factors for asymptomatic AHR (OC scores $P < .001$ and eosinophil counts $P = .010$). The OC score had a higher predictive value for AHR (area under curve, 0.800) than eosinophil counts (area under the curve, 0.637). When the OC score was 3 or higher, the sensitivity was 75.0%, specificity was 77.9%, and positive predictive value was 68.8%.
Conclusion: The findings validate a prospective assessment of sinus computed tomography as a screening tool for AHR in patients with CRS.

Introduction

Chronic rhinosinusitis (CRS) is a chronic inflammatory disease of the upper airway that is tightly linked to lower respiratory tract disorders, such as asthma. Airway hyperresponsiveness (AHR), the main feature of asthma, stems from an ongoing inflammatory and remodeling process of an undetermined origin. Epidemiologic data indicate that patients with asymptomatic AHR (AAHR) are at a high risk of developing asthma.[1,2] The proportion of asthma and AAHR increases in patients with CRS when compared with a general Western population.[3,4] However, data on the proportion of AAHR in Asian patients with CRS are limited.

Studies focusing on how to detect AHR in patients with CRS are limited. Only blood eosinophil counts and nasal symptoms have been used to predict AHR in patients with nasal polyps (NPs) with moderate sensitivity and specificity.[5] Although the use of sinus computed tomography (CT) in patients with CRS and coexisting asthma has been well described in the literature,[6–8] the sinus CT findings in AAHR patients have not been delineated yet. On the other hand, the olfactory cleft (OC) score is a predictor of eosinophil CRS (ECRS), and asthma comorbidity is a risk factor for ECRS.[9] However, it is unclear whether sinus CT score and OC scores can predict AHR in CRS. The aims of this study were to evaluate the sinus CT features of patients with CRS and AHR and the diagnostic values of sinus CT scores for predicting AHR in patients with CRS. We theorized that patients with CRS and AHR had specific sinus CT features that could identify their AHR.

Methods

Study Participants

This study enrolled 125 consecutive CRS patients (≥18 years old) undergoing functional endoscopic sinus surgery in Otorhinolaryngology

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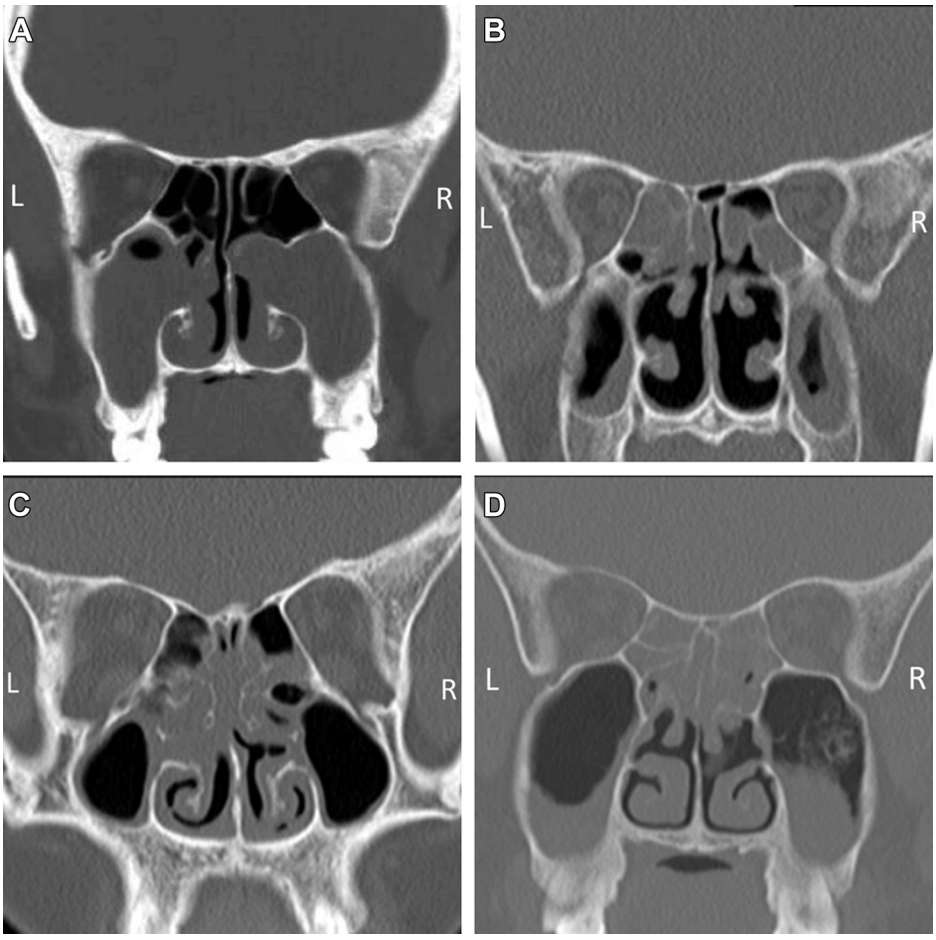

Figure 1. Olfactory cleft (OC) score was observed on the posterior ethmoid sinus and superior turbinate level. A, Each OC score was 0. B, Left OC score was 0, right OC score was 2, and total OC score was 2. C, Each OC score was 1, and total OC score was 2. C, Each OC score was 2, and total OC score was 4.

Hospital, First Affiliated Hospital of Sun Yat-sen University, between September 2012 and August 2013. The diagnosis of CRS was based on a European position paper on rhinosinusitis and NPs.[10] Patients were excluded if they had any respiratory disease except asthma (eg, chronic obstructive pulmonary disease); had acute respiratory infection in 4 weeks; or had taken any corticosteroids (systemic and local), antihistamines (systemic and local), leukotriene receptor antagonists, β_2-receptor agonists, or anticholinergic agents within the 2 weeks before the bronchial provocation test. Patients avoided smoking, cold air, and strenuous exercise. The study had ethical approval from the institutional review board of the First Affiliated Hospital of Sun Yat-sen University. All participants provided written informed consent to participate in this study.

Study Design

This prospective, single-blinded study collected information on asthma history. All patients except those diagnosed as having asthma were subjected to lung expiratory volume tests and bronchial provocation and dilation tests and then divided into AHR and non-AHR (NAHR) groups according to the test results. AHR were defined as a 20% or greater reduction in the forced expiratory volume in 1 second after serial administration of histamine up to a concentration of 8 mg/mL or less. The patients with diagnosed asthma were enrolled in the AHR group. The patients without diagnosed asthma were carefully questioned about the presence of recurrent symptoms of asthma, including wheezing, coughing, chest tightness, and shortness of breath. The patients without these symptoms but with positive provocation test results were enrolled in the AAHR. The following parameters between groups were compared: sinus CT, blood eosinophil number and ratio, and concurrent allergic rhinitis and NPs.

CT and Sinus Score

Study participants underwent sinus CT examination in a supine position. The CT examination collected 1-mm axial images, which were reconstructed offline and reformatted to 3-mm coronal images for analysis (Toshiba Aquilion, Tokyo, Japan). Sinus CTs were reviewed by an investigator masked to the patients' clinical condition. CT scoring was based on the Lund-Mackay scoring system,[11] supplemented with the OC score. In the Lund-Mackay staging system, which is based on a simple numeric score derived from the CT, each sinus group is assigned a numeric grade: 0, no abnormality; 1, partial opacification; and 2, total opacification. The sinus groups include the maxillary sinus, frontal sinus, sphenoid sinus, anterior ethmoid sinus, and posterior ethmoid sinuses. The ostiomeatal complex is scored as 0 (not obstructed) or 2 (obstructed). The OC score was observed on the posterior ethmoid sinus and superior turbinate level. Each OC was awarded 0 to 2 points: 0, no abnormality; 1, partial opacification; and 2, total opacification (Fig 1).[9] The total score was the Lund-Mackay total scores supplemented with the OC scores, producing a maximum of 28 points.

Statistical Analysis

SPSS statistical software, version 16.0 (SPSS Inc, Chicago, Illinois), was used for statistical analyses. Continuous variables are