

Original article

United airways again: high prevalence of rhinosinusitis and nasal polyps in bronchiectasis

Background: Although various relationships between the lower and upper airways have been found, the association of bronchiectasis with chronic rhinosinusitis and nasal polyps has not been thoroughly evaluated. This study was undertaken to examine the association of idiopathic and postinfective bronchiectasis with chronic rhinosinusitis and nasal polyposis.

Methods: In a prospective study, 56 patients with idiopathic and 32 with postinfective bronchiectasis were evaluated for chronic rhinosinusitis and nasal polyposis by using EP³OS criteria and assessing: symptoms score, nasal endoscopy, sinonasal and chest CT scan, nasal and lung function and nasal and exhaled NO.

Results: Most bronchiectasis patients (77%) satisfied the EP³OS criteria for chronic rhinosinusitis, with anterior (98.5%) and posterior (91%) rhinorrhea and nasal congestion (90%) being the major symptoms. Patients presented maxillary, ethmoidal and ostiomeatal complex occupancy with a total CT score of 8.4 ± 0.4 (0–24). Using endoscopy, nasal polyps with a moderate score of 1.6 ± 0.1 (0–3) were found in 25% of patients. Nasal NO was significantly lower in patients with nasal polyposis (347 ± 62 ppb) than in those without them (683 ± 76 ppb; $P < 0.001$), and inversely correlated ($R = -0.36$; $P < 0.01$) with the ostiomeatal complex occupancy. In the chest CT scan, patients with chronic rhinosinusitis showed a higher bronchiectasis severity score (7.2 ± 0.5 ; $P < 0.001$) than patients without (3.7 ± 0.7). The prevalence of chronic rhinosinusitis, nasal polyps and other outcomes were similar in idiopathic and postinfective bronchiectasis.

Conclusions: The frequent association of chronic rhinosinusitis and nasal polyposis with idiopathic and postinfective BQ supports the united airways concept, and it suggests that the two type of bronchiectasis share common etiopathogenic mechanisms.

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Bronchiectasis (BQ) is a chronic bronchial disease with a structural derangement of the bronchial wall, with permanent and irreversible destruction and dilatation, retained secretions and recurrent infections that cause inflammation, obstruction, damage of the lower airway, significant impact on health care and impairment of the quality of life (1, 2). BQ are a consequence of a variety of different diseases where infection and excessive mucous production appear to be the most important contributory factors. Although more than 50% of BQ cases are still considered idiopathic, the study of contributing potential causes may have important implications for the management of the disease (3).

Chronic rhinosinusitis (CRS) is an inflammatory disease of the nose and sinus mucosa that, despite different hypotheses about its cause, remains poorly understood

(4). CRS has become one of the most common chronic diseases (5), with studies reporting that in the general population up to 6% of subjects suffered from chronic nasal discharge (6). Nasal polyps (NP) are smooth, grape-like structures that arise from the inflamed nasal mucosa. NP usually occurs in association with CRS. Smell disorders are more prevalent in patients with NP than in CRS patients with no NP (7).

The recently coined concept 'united airways', also known as 'one airway, one disease', maintains that inflammatory processes of the upper and lower airway often co-exist and share common etiopathogenic mechanisms. It has been mainly explored with reference to asthma and rhinitis. Epidemiological data indicate that asthma and rhinitis frequently occur in the same patient. It has also been reported that the severity of rhinitis

directly correlates with asthma severity. NP are also frequently associated with asthma. Over 84% of sino-nasal CT scans have been found to be abnormal in severe asthmatic patients, with a correlation between the CT scores, sputum eosinophilia and pulmonary function (8). In addition, both the medical and surgical treatments of CRS and NP may benefit concomitant asthma (9).

Upper airway symptoms are also frequent in patients with chronic obstructive pulmonary disease (COPD) and cause impairment in patients' quality of life (10). Increased nasal inflammation has also been reported in COPD patients (11). Patients with allergic and nonallergic asthma and COPD show increased nasal symptoms and more nasal inflammation (12).

CRS and NP frequently occur in cystic fibrosis and primary ciliary dyskinesia. Both are distinguish diseases with clear pathological mechanisms and with a consequence of pulmonary pathology due to recurrent airway infections (13). However, few studies have addressed the potential co-morbidity between noncystic BQ and upper airway disease, including CRS and NP. We hypothesize that, according to the 'united airway' concept, most so-called idiopathic bronchiectasis should be the consequence of a process affecting the entire airways, including the nose and the paranasal sinuses. In contrast, BQ considered secondary to infectious insults of the lower airways (postinfective BQ) usually occurring in early years, such as after pneumonia or in whooping cough, should not be necessarily associated with CRS. If this hypothesis holds true, most patients with idiopathic bronchiectasis should suffer from nasal and sinus diseases, and the severity of CRS and bronchiectasis should also be correlated. In contrast, in postinfective BQ, the upper airway should rarely be involved. To test this hypothesis, we: (1) examined the association of idiopathic and postinfective BQ and CRS with and without NP and (2) assessed the prevalence of symptoms, sinusal occupancy, nasal polyp size, nasal and lung function and inflammation in patients with BQ and concomitant CRS and NP.

Methods

Study subjects

Eighty-eight consecutive patients with idiopathic and postinfective BQ, diagnosed in the pneumology clinic, were included in a prospective study from April 2004–June 2006. The diagnosis of BQ was performed on the basis of characteristic clinical symptoms and CT scanning. The Ethics Committee of our institution approved the study and signed informed consent was obtained from all patients.

Diagnosis and extent of BQ

BQ predisposing factors were assessed: serum immunoglobulin (Ig), IgG, IgA, IgM, IgG subclasses, specific antibody response to pneumococcal antigens, alpha1-antitrypsin deficiency, cystic fibrosis (sweat test and genotyping), allergic bronchopulmonary aspergillosis and ciliary dysfunction. A high resolution CT (HRCT) scan of

the chest was performed during the 3-month period prior to the sinonasal examination and the extent of BQ in each lobe was graded, using a scale from 0 to 3 (0, no involvement; 1, segment involved; 2, more than one segment involved and 3, gross cystic BQ involving the entire lobe) (14). Forced spirometry was performed according to standard methods and percent-predicted FEV₁ (FEV₁%), FVC and FEV₁/FVC was chosen for analysis, as previously reported. Exhaled nitric oxide (eNO) was measured according to standardized methods (15).

Postinfective BQ was diagnosed when the patient reported a history of symptoms appearing immediately after a severe infection, such as pneumonia, tuberculosis or whooping cough. Idiopathic BQ was diagnosed when known causes of BQ had been ruled-out.

Diagnosis and extent of sinusitis and nasal polyps

Patients with BQ were evaluated for CRS and NP following EP³OS guidelines (4). The diagnosis of NP was based on the visualization of nasal polyps under endoscopic examination. To characterize the involvement of upper airway disease in patients with BQ, the following diagnostic tools were used: nasal symptom score, nasal endoscopy, sinonasal CT-scan, nasal function and nasal NO.

Nasal congestion/obstruction/blockage, reduction or loss of the sense of smell, anterior rhinorrhea, postnasal drip, facial pain/pressure, itching and sneezing were scored using the Rasp classification (0–3) (16). Polyp size was scored from 0 to 3 for each nasal cavity using nasal endoscopy, following Lildholdt's classification (17). A radiologist blindly staged sinus occupation for each patient, using CT scanning and the Lund-MacKay score system (0–24) (18). Nasal airflow was measured by active anterior rhinomanometry and expressed as the flow generated at a pressure of 150 Pa (cm³/s). Nasal volume within the distance of 6 cm from the nostrils (volume 0–6 cm³) was measured using acoustic rhinometry, according to a method previously reported (15). nNO was obtained from one nostril using a negative pressure pump with a flow rate of 3 l/min, as reported elsewhere (15).

Other studies

Skin prick testing to most common allergens, nasal eosinophilia, blood eosinophil counts and serum total and specific IgE levels were carried out, using previously reported standard methods.

Statistical analysis

Data analysis and statistics were performed using SPSS for Windows (SPSS 12.0, Chicago, IL, USA). Comparisons between categorical variables used the Pearson's χ^2 statistic (or the Fisher's exact test for small samples). When comparing continuous variables with categorical predictors, the Student's *t*-test was used. Pearson correlation coefficients were used to examine the association between gender, age, nasal symptoms, nasal polyps, CT opacification, lung function, nasal patency and nasal/exhaled nitric oxide. Values of *P* < 0.05 were considered statistically significant.

Results

Demographic data

Fifty-six of the 88 patients (64%) were classified as having a postinfective disease, while 32 (36%) were classified as having an idiopathic disease, of those one had an

Table 1. Epidemiological characteristics of BQ patients included in the study

	All BQ patients	No CRS	CRS	CRS without NP	CRS with NP	ID	PI
Patients, <i>n</i> (%)	88	20 (23)	68 (77)	46 (52)	22 (25)	32 (37)	56 (63)
Age (years)†	55 ± 2	59 ± 3	54 ± 2	56 ± 2	49 ± 4*	53 ± 3	58 ± 1
BQ age diagnosis (years)†	40 ± 2	47 ± 4	38 ± 2.5	39 ± 3	36.5 ± 5*	45 ± 3	40 ± 3
Female (%)	69	50	75*	87*	50**	84*	68
F/M ratio	2.3 : 1	1 : 1	3 : 1	5.6 : 1	1 : 1	5.2 : 1	2.1 : 1
Smoking habit							
Ex-smokers (%)	24	50	16	13	23	16	26
Smokers (%)	6	0	7	9	4.5	7	5
Packs/year†	23 ± 3	25.5 ± 5	22 ± 4	20 ± 4	27 ± 9	22.5 ± 3	25 ± 4
Lung function							
FEV ₁ (%)†	83 ± 3	90 ± 4	81 ± 3	81 ± 4	80 ± 6	85 ± 5	82.5 ± 3
FEV ₁ /FVC (%)†	93 ± 1.5	96 ± 3	92 ± 2	92 ± 2	92 ± 3.5	93.3 ± 4	93.3 ± 2

BQ, bronchiectasis; CRS, chronic rhinosinusitis; NP, nasal polyposis; ID, idiopathic BQ; PI, postinfectious BQ; SEM, standard error of the mean; M, male; F, female; FEV₁, forced expiratory volume at 1 s; FVC, forced vital capacity. Unpaired Student's *t*-test: **P* < 0.05, compared to CRS- patients; ***P* < 0.05, compared to patients with CRS without NP.

†Data presented as mean ± SEM.

inflammatory bowel disease, and another rheumatoid arthritis. The mean age was 55 ± 2 years (ranging from 21 years to 78 years), 6% were current smokers and 24% were ex-smokers. The mean age at BQ diagnosis was 40 ± 2 years. Patients with NP (36.5 ± 5 years) were diagnosed with BQ earlier than patients with no sinonasal pathology (47 ± 4 years). Patients with CRS, 69% of them female, had a significantly higher female ratio (3 : 1), and this was even higher in patients with CRS-NP (5.6 : 1), compared to patients with no CRS (1 : 1) (Table 1).

Allergic and immunologic studies

C-reactive protein level was significantly increased in patients with CRS (1.3 ± 0.2 mg/dl; *P* < 0.05) compared with patients with no CRS (0.6 ± 0.2 mg/dl). The main allergic and immunologic characteristics are described and compared with normal values in Table 2. No significant differences between groups (including CRS vs No CRS) were found.

Lung function

Mean FEV₁ was 83 ± 3% predicted. FEV₁ in patients with CRS (81 ± 3%) was lower than in those with no CRS (90 ± 4%) but the difference did not reach statistical significance (*P* = 0.06). No other differences were found in spirometry between groups, and no correlation was observed with nasal symptoms, nasal polyposis or CT scores (Table 1).

Chest CT-scan

Patients with CRS (7.2 ± 0.5; *P* < 0.001) showed a higher BQ severity score than patients with no CRS (3.7 ± 0.7) (Fig. 1). No differences were observed between patients with and without NP.

Table 2. Allergic and immunologic outcomes of BQ patients

	BQ patients	Normal values
<i>Outcomes</i>		
Positive nasal eosinophilia, <i>n</i> (%)	3	<1†
Positive skin prick test to allergen, <i>n</i> (%)	20	20–30†
Positive prick test to moulds, <i>n</i> (%)	9	6–12†
Positive <i>Aspergillus</i> recombinant allergens, <i>n</i> (%)	3	Not described
Positive IgE to mould, <i>n</i> (%)	7	Not described
Blood eosinophils (%)‡	3.5 ± 0.3	<5†
Blood eosinophils (cells/vol)‡	0.26 ± 0.02	<0.5†
Positive <i>Aspergillus</i> precipitins (%)	4.5	Not described
<i>Immunoglobulins</i>		
IgE (KU/l)	114 ± 23	<100
IgA (g/l)	2.341 ± 119	0.66–3.650
IgM (g/l)	1.352 ± 179	0.36–2.610
IgG (g/l)	11.519 ± 367	6.800–15.300
IgG1 (g/l)	7.186 ± 260	4.900–11.400
IgG2 (g/l)	3.537 ± 156	1.500–6.400
IgG3 (g/l)	0.51 ± 0.03	0.2–1.100
IgG4 (g/l)	0.67 ± 0.08	0.08–1.400

†Normal values in the Spanish general population from Alergológica 2006 (32).

‡Data presented as mean ± SEM.

Sinonasal symptoms

Seventy-seven percent of patients fulfilled the EP³OS criteria for CRS. Anterior rhinorrhea (89%), postnasal drip (77%) and nasal congestion (77%) were scored by patients as major complaints, while sneezing (59%), facial pain (40%), reduction/loss of smell (39%) and itching (36%) were less frequent. Patients with CRS reported anterior rhinorrhea (98.5%), postnasal drip (91%) and nasal congestion (90%), with significant differences (*P* < 0.001) in all symptoms except sneezing, compared to patients with no CRS. Patients with CRS had significant higher scores (*P* < 0.001) in total symptom

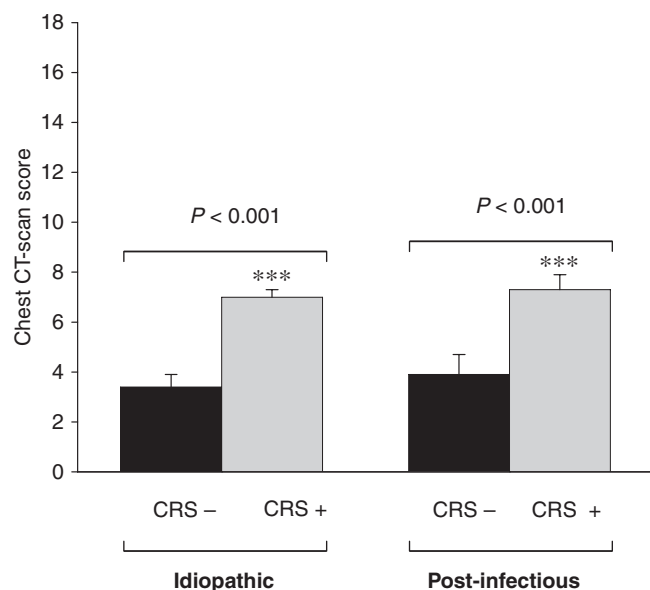


Figure 1. Chest HRCT scan score (BQ severity) in patients with idiopathic or postinfectious bronchiectasis without (CRS-) and with (CRS+) chronic rhinosinusitis. Unpaired Student's *t*-test: ****P* < 0.001 compared to CRS- patients.

score (8.4 ± 0.4), especially for anterior rhinorrhea (1.9 ± 0.1), postnasal drip (1.8 ± 0.1) and nasal obstruction (1.6 ± 0.1), than patients with no CRS.

Patients with NP reported more reduction/loss of smell (77%; *P* < 0.001) compared to patients with no NP (30%), as well as higher total symptom scores, nasal obstruction and itching (Fig. 2).

Nasal polyp size

By nasal endoscopy, 22 patients (26%) with BQs had mild-moderate nasal polyps (1.6 ± 0.1), of whom only 32% of patients with NP had previously been diagnosed. The diagnosis of BQs had been performed 9 years earlier in patients with CRS (38 ± 2.5 years) than in those without CRS (47 ± 4 years).

Sinusal occupancy

CT scan was affected in 66 patients (86%), with a score of 6.6 ± 0.5 , and a predominance of maxillary sinus (1.8 ± 0.1), ostiomeatal complex (1.7 ± 0.2) and anterior ethmoid sinus (1.5 ± 0.1). Patients that fulfilled the EP³OS criteria of CRS showed a total CT score of 8.4 ± 0.4 (Fig. 3).

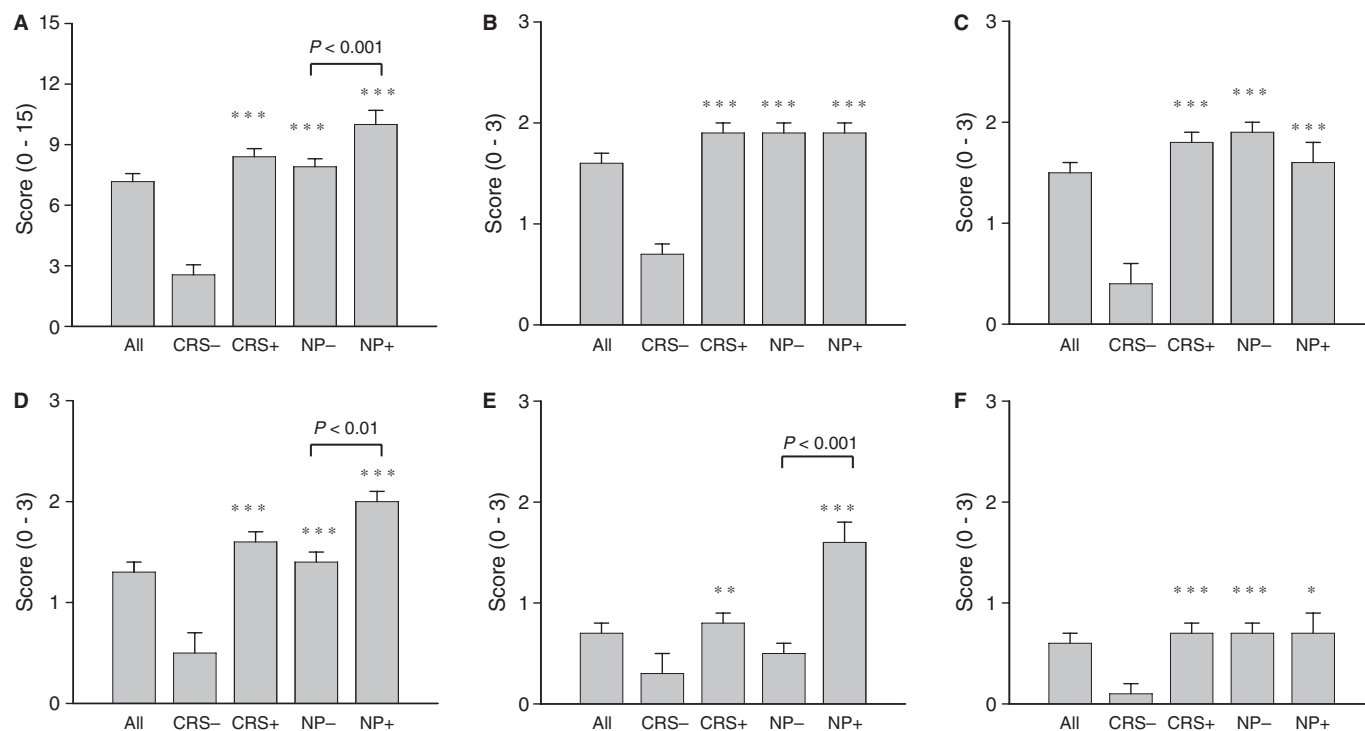


Figure 2. Nasal symptom scores (Table 1) in patients with bronchiectasis without (CRS-) and with (CRS+) chronic rhinosinusitis, and without (NP-) or with (NP+) nasal polyposis. (A) Total symptom score (TSS5), (B) anterior rhinorrhea, (C) postnasal drip, (D) nasal congestion/blockage, (E) loss of sense of smell and (F) facial pain/pressure. Unpaired Student's *t*-test: **P* < 0.05, ***P* < 0.01, ****P* < 0.001, compared to CRS- patients.

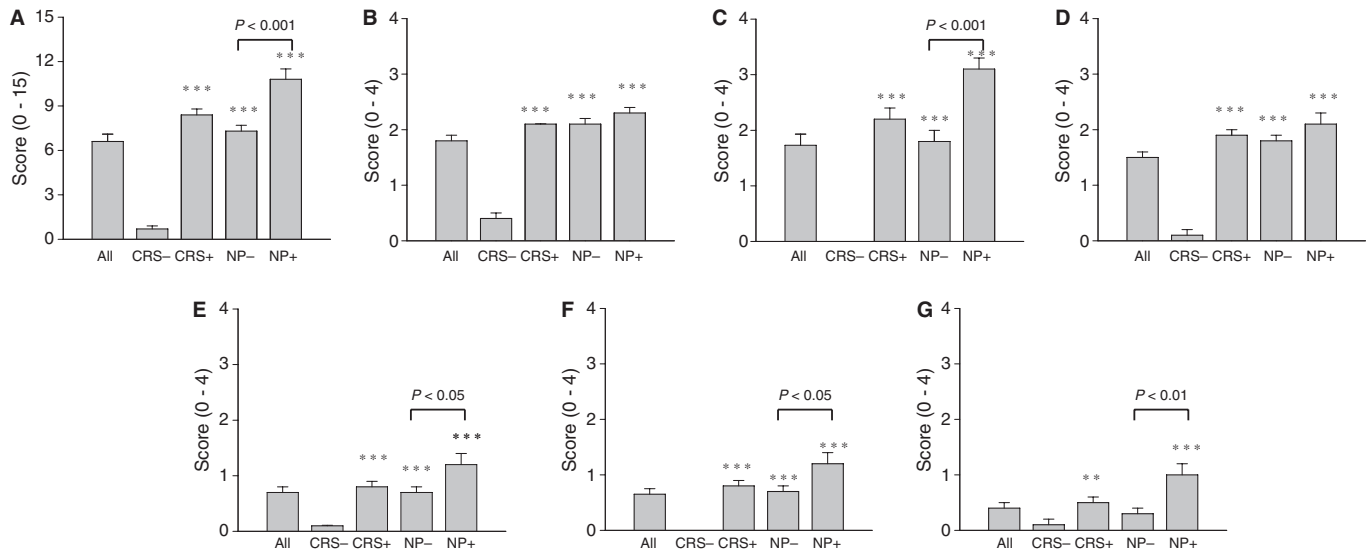


Figure 3. Sinonasal CT occupancy in patients with bronchiectasis without (CRS-) and with (CRS+) chronic rhinosinusitis, and without (NP-) and with (NP+) nasal polyposis. (A) Total CT score, (B) maxillary sinus, (C) ostiomeatal complex, (D) anterior ethmoid sinus, (E) posterior ethmoid sinus, (F) sphenoid sinus and (G) frontal sinus. Unpaired Student's *t*-test: ***P* < 0.01, ****P* < 0.001, compared to CRS- patients.

Patients with CRS mainly presented maxillary and ethmoid opacification. Patients with CRS reported significantly higher CT scores (*P* < 0.001) than patients without CRS in: total score (8.4 ± 0.4 vs 0.7 ± 0.2), maxillary (2.1 ± 0.1 vs 0.4 ± 0.1), ostiomeatal complex (2.2 ± 0.2 vs 0), anterior ethmoid (1.9 ± 0.1 vs 0.1 ± 0.1), posterior ethmoid (0.8 ± 0.1 vs 0.1 ± 0.1), frontal (0.5 ± 0.1 vs 0.1 ± 0.1) and sphenoid (0.8 ± 0.1 vs 0) sinuses.

Patients with NP presented significantly higher CT scores (*P* < 0.05) than patients with no NP in: total score (10.8 ± 0.7 vs 7.3 ± 0.4), ostiomeatal complex (3.1 ± 0.2 vs 1.8 ± 0.2), posterior ethmoid (1.2 ± 0.2 vs 0.7 ± 0.1), frontal (1 ± 0.2 vs 0.3 ± 0.1) and sphenoid (1.2 ± 0.2 vs 0.7 ± 0.1) sinuses.

Nasal function

Using anterior rhinomanometry, patients with CRS showed a greater nasal obstruction (590 ± 37 cm³/s) compared to those with no CRS (854 ± 81.5 cm³/s; *P* < 0.01) (Fig. 4A). Acoustic rhinometry carried out on patients with NP showed a significantly lower nasal volume (13 ± 0.7 cm³) than those with no CRS (15 ± 0.8 cm³, *P* < 0.05) (Fig. 4B).

Inflammation markers

nNO was significantly lower in patients with NP (347 ± 62 ppb) compared to those with no CRS (683 ± 76 ppb, *P* < 0.001) and CRS with no NP (620 ± 47 ppb) (Fig. 4C). Nasal NO was inversely correlated with the occupancy of the ostiomeatal complex

(*R* = -0.36; *P* < 0.01) in patients with NP. No differences between groups were found on exhaled NO production (Fig. 4D).

CRS and nasal polyps in idiopathic vs postinfective bronchiectasis

We were interested in contrasting the results of patients with postinfective with those classified as idiopathic. No significant differences were observed between patients diagnosed with idiopathic and postinfective BQs, in total symptoms score (6.9 ± 0.8 vs 7 ± 0.5), nasal polyp prevalence (25% vs 25%) and the sinonasal occupancy, as detected by the CT score (6.7 ± 1.1 vs 6.0 ± 0.5). The only exception was olfaction, which was more affected in idiopathic bronchiectasis (1.08 ± 0.2 vs 0.5 ± 0.1). No significant differences between idiopathic and postinfective BQs were found in allergic and immunologic studies, lung function, chest CT-scan, nasal function and inflammation markers (data not shown).

Discussion

The main findings of the present study are: (1) there is a high prevalence of CRS (77%) and NP (26%) in BQ patients (postinfective and idiopathic), (2) the severity of BQ is related to the presence of CRS and NP, (3) the percentage of patients with CRS and NP is similar in postinfective and idiopathic BQ and (4) nasal NO is inversely correlated to the severity of CRS and the presence of NP.

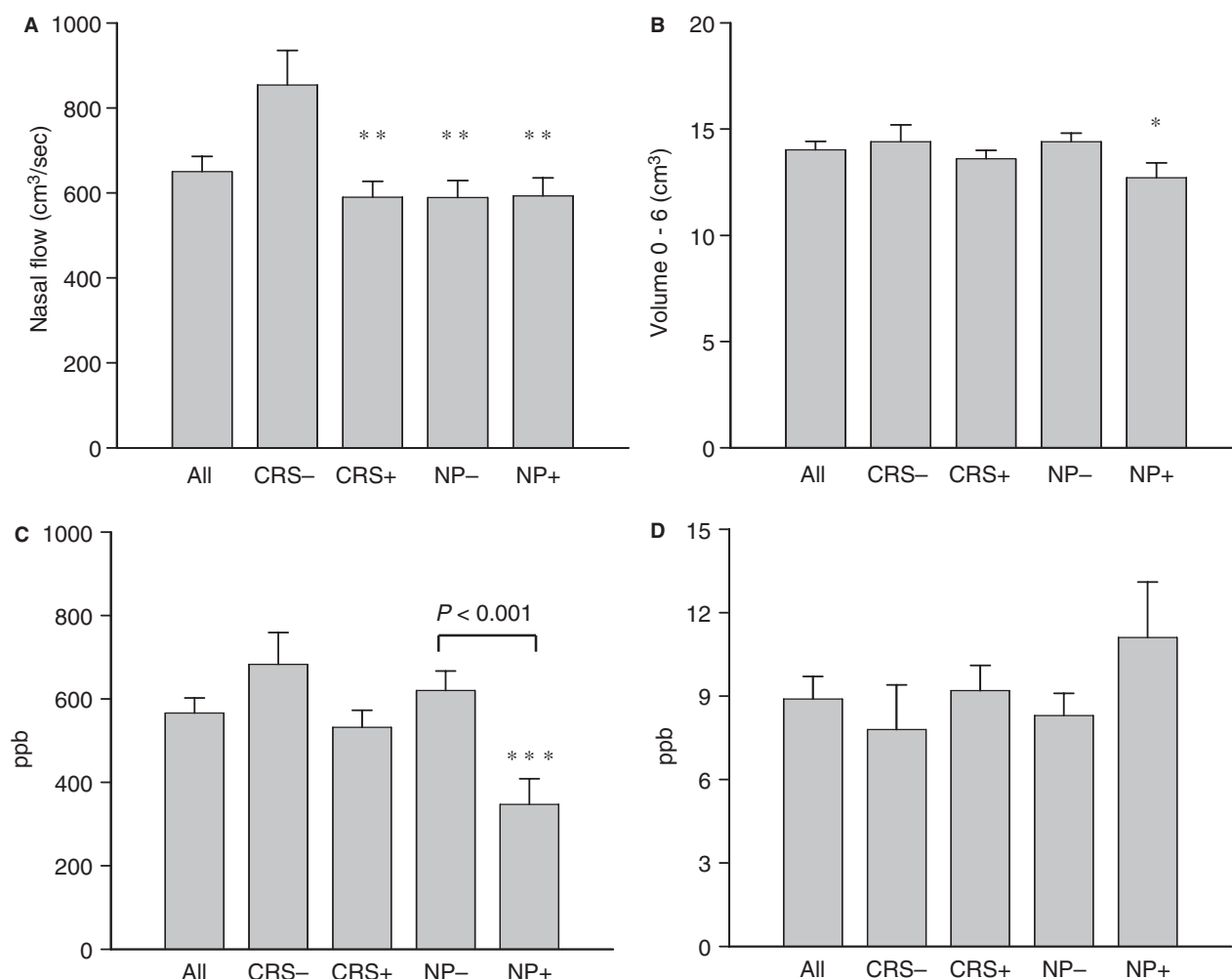


Figure 4. Nasal function measurements and nasal and bronchial inflammation measured by nitric oxide (NO) in patients with bronchiectasis without (CRS-) and with (CRS+) chronic rhinosinusitis, and without (NP-) and with nasal polyposis (NP+). (A) Anterior rhinomanometry, (B) acoustic rhinometry, (C) Nasal NO and (D) Exhaled NO. Unpaired Student's *t*-test: **P* < 0.05, ***P* < 0.01, ****P* < 0.001 compared to CRS- patients.

High prevalence of CRS and NP in bronchiectasis

This is the first study that deeply examines and describes the presence and extension of sinonasal pathology in patients affected by stable BQs. Many studies have related upper and lower airway pathology and have confirmed a correlation between the degree of upper and lower airway inflammation in asthma (4) and COPD (4), but no studies have thoroughly assessed sinonasal pathology in stable bronchiectasis. Previous studies observed an increased prevalence of rhinosinusitis in patients with BQs ranging from 58% to 70% (14, 19–21). However, the diagnostic criteria used in these studies were not clearly mentioned and, in some cases, the diagnosis was based only on symptoms and sinusal standard X-ray. Because the assessment of CRS and NP was made without using the support of CT scanning and endoscopy, the disease was imprecisely defined and its

extension poorly assessed. In one study, 47% of patients reported a history of rhinosinusitis but the data on nasal symptoms were not specified, while no sinonasal CT-scan or nasal endoscopy were not performed (20). Another recent study concluded that chronic rhinosinusitis was present in 70% of BQ patients (21). This study defined CRS as a chronic upper respiratory tract disease present for more than a year, with common symptoms that vary from mild intermittent nasal discharge to severe purulent sinusitis. Forty-seven percent of patients had sinus anomalies ranging from mucosal thickening to severe pan-sinusitis in a conventional radiological study. Other nasal symptoms present in CRS, such as nasal obstruction and smell disorders, were not reported.

Currently, the European Academy of Allergy and Clinical Immunology (EAACI) has published evidence-based recommendations on diagnosis and

treatment: the EP³OS consensus (4). Clinical symptoms, endoscopic signs and/or CT changes persisting more than 12 weeks define CRS, including nasal polyps. In our study, 98% of patients with bronchiectasis presented nasal symptoms. Patients with BQs presented anterior rhinorrhea, postnasal drip and nasal blockage as the major complaints, in accordance with the major symptoms reported in EP³OS. An important endoscopic sign, observed in more than 60% of patients, was mucous discharge from the middle meatus. Using EP³OS criteria, 77% of patients with BQ presented CRS, while 25% presented mild to moderate NP.

C-reactive protein level was significantly increased in patients with CRS, compared with patients with no CRS. Patients with NP were diagnosed with BQs more than 10 years earlier than patients with no sinonasal pathology. Maxillary and ethmoid sinuses were mostly affected in patients with CRS, either with or without NP, while patients with no NP had significant lower scores in CT than patients with NP. Chest imaging (HRCT) is the gold-standard method for diagnosing BQ (22), and in our study patients with CRS presented a significant increase in BQ imaging score, with no differences between CRS, with or without NP.

All in all, these findings suggest that the presence of CRS and NP in a patient with BQ is a marker of a more active and extended airway inflammatory process.

CRS and NP occur with similar frequency in idiopathic and postinfectious bronchiectasis

A number of bronchiectasis is commonly considered postinfectious, mostly on the basis of a previous history of severe pulmonary infections preceding the symptoms of bronchiectasis and radiological abnormalities. However, the existence of either permanent bronchial dilatations before the infective episode or a defective defensive mechanism that precedes and/or accounts for both the infective episode and the posterior development of bronchiectasis cannot be excluded as the origin of some of these supposedly postinfective BQs. We assumed that in the case of bronchiectasis resulting from a direct injury to the lower airways, the upper airways should remain preserved from any nasal and sinus process. Conversely, and according to the united airway theory, most idiopathic BQs resulting from as yet unknown airway defensive or metabolic deficiency should be associated with upper airway diseases. Since we could not find significant differences between postinfectious and idiopathic bronchiectasis, in either the prevalence or the extension of CRS and NP, our results suggest that most of BQs considered as secondary to direct infectious injuries of the lower airways share common mechanisms with idiopathic BQs.

Nasal NO is inversely correlated to the occupation of the ostiomeatal complex. In asthma patients, the ethmoi-

dal sinus is the most severely involved when CRS is present (23), while in our study, BQ patients show a predominant maxillo-ethmoidal involvement with obstruction of the ostiomeatal complex.

In healthy upper airways, nitric oxide is continuously generated and secreted by the maxillary sinus through the ostiomeatal complex and then diffuses into the nasal cavities (24). The ostiomeatal complex is a functional unit that comprises maxillary sinus ostia, anterior ethmoid cells and their ostia, ethmoid infundibulum, hiatus semilunaris and middle meatus. NO has antiviral and antibacterial properties and plays a major role in innate immunity.

It is known that nasal NO is increased in allergic rhinitis but the data on CRS and NP are controversial (25). A previous study found lower levels of nNO in CRS patients than in healthy controls (26). Other studies also show that nasal NO levels are inversely correlated with the extent of NP, possibly related to the blockage of the ostiomeatal complex (27, 28). nNO levels have also been shown to inversely correlate with both the extent of the CT scan and the number of occluded paranasal sinuses (25, 27). In our study, nasal NO concentrations did not differ between groups, except in patients with NP, in whom the nNO was found at lower concentrations, with an inverse correlation with the ostiomeatal complex CT score.

Kharitonov et al. (29) have reported increased exhaled NO concentrations in BQ, in contrast with findings in other studies (30, 31). Our results concur with those reporting no increase in exhaled NO in BQ.

In summary, almost four out of five patients with BQ (77%) presented criteria for CRS, and one out of every four patients had NP at nasal endoscopy (25%). These results support the 'united airways' concept and suggest that most of the so-called postinfective bronchiectasis probably result from as yet unknown processes that affect the entire airways, rather than being the consequence of an injury (postinfectious and others) specifically affecting only the lower airways. Finally, our findings also suggest that patients with BQ should always be evaluated for CRS and NP, while patients with CRS and NP should also be assessed for lower airway diseases, including BQ.

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